The Engineer

NOVEMBER 20, 1953 28, ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS

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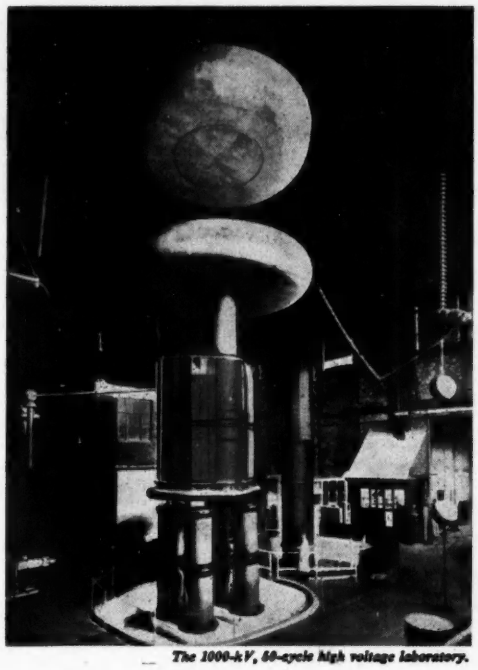

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THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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WORDING OF ADVERTISEMENTS: Approximately the firs. 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

LEICESTERSHIRE

Principal: H. L. HASLEGRAVE, Wh.Sc., Ph.D., M.A., M.Sc.

DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING

SENIOR LECTURER

Applications are invited for the appointment of a SENIOR LECTURER in Mechanical Engineering, to commence duties on 1st May, 1954.

Applicants should hold an Honours Degree of a British University and have had industrial experience of a responsible nature. Previous teaching experience is desirable and preference will be given to candidates qualified to teach Thermodynamics to Honours Degree standard.

Salary will be paid according to the scale £1000–£25–£1150, with an additional annual allowance of £40.

Further particulars and application form may be obtained from The Registrar, to whom completed forms should be returned as soon as possible. E6106

UNIVERSITY OF BRISTOL

STRUCTURAL ENGINEERING DRAUGHTSMAN

STRUCTURAL ENGINEERING DRAUGHTSMAN required for drawing and design work on engineering laboratory apparatus, together with the supervision of the installation of such apparatus and of building work in connection therewith. The applicant should be not less than 30 years old and should have had experience in structural engineering. Some acquaintance with building specifications and with the provision of power and heating services would be an advantage. Salary, according to experience and qualifications, initially in the range £400 to £600 per annum. University superannuation scheme. —Apply in writing to the Registrar, The University, Bristol, 8. E6079

THE POLYTECHNIC,

309, REGENT STREET, W.1

MECHANICAL AND CIVIL ENGINEERING DEPARTMENT

ASSISTANT GRADE B IN MECHANICAL ENGINEERING

Applications are invited for a full-time post of ASSISTANT GRADE B IN MECHANICAL ENGINEERING. Candidates should be Graduates with industrial experience.

The salary scale commences at £490 per annum, rising by annual increments of £25 to £765, plus London allowance of £36 or £48 per annum, with additional allowances for graduateship and training where applicable.

The commencing salary may include increments for previous teaching, professional and war service.

Further particulars and application form, to be returned not later than 7th December, may be obtained by sending a stamped, addressed, foolscap envelope to the undersigned.

J. C. JONES,
Director of Education.
E6083

COUNTY BOROUGH OF ROTHERHAM,

EDUCATION COMMITTEE

ROTHERHAM TECHNICAL COLLEGE

Principal:
G. E. COOKE, M.A. (Cantab), A.M.I.C.E.

SENIOR LECTURER

Applications are invited for the appointment of SENIOR LECTURER in the Department of Mechanical, Production and Civil Engineering.

Candidates should possess a Degree, be Corporate Members of a professional Institution, and should have had sound industrial experience.

The successful applicant will be required to teach to Higher National Diploma and Degree standard. Facilities are available for research.

Salary in accordance with the Burnham Technical Award (1951), viz., £1040–£25–£1190.

Application forms may be obtained from the undersigned, to whom they should be returned not later than two weeks after the appearance of this advertisement.

R. BLOOMER,
Director of Education.
Education Offices,
Rotherham. E6123

ESSEX

SOUTH-WEST ESSEX TECHNICAL COLLEGE,

FOREST ROAD, WALTHAMSTOW, E.17

LECTURER

Required, as soon as possible, LECTURER in Mechanical Engineering Subjects to Final Degree standard. Candidates must be Graduates and should possess suitable professional qualifications and some industrial and teaching experience.

Salary £940 by £25 to £1040 per annum (men) plus London allowance.

Applications (no forms), stating full details of training, qualifications and experience, to the Clerk to the Governors as soon as possible. E6156

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

HANDICRAFT

WORDSWORTH (M) SCHOOL,
Palatine Road, Stoke Newington, N.16 (240 Boys, 230 Girls, 11–15)

MASTERS

Applications invited from qualified HANDICRAFT MASTERS for appointment to Council's service and assignment to this school to teach technical drawing and metalwork. Burnham (London) scale salary.—Apply at once to Headmaster of School on Form EO/TS40, obtainable from Education Officer (TS4), County Hall, S.E.1 (send stamped, addressed foolscap envelope). (1272.) E6108

BRITISH ELECTRICITY AUTHORITY

GENERATION CONSTRUCTION SUB-DEPARTMENT

PRINCIPAL ASSISTANT ENGINEERS

Generation Construction Sub-Department, Headquarters, London, require :

(a) PRINCIPAL ASSISTANT ENGINEER (Electrical), responsible for the supervision of a section concerned with the production, inspection and test of electrical plant associated with the Authority's power station and transmission construction programmes. Wide up-to-date experience in methods and procedures for the production, inspection and test of such plant is essential, and knowledge of modern manufacturing processes would be an advantage.

(b) PRINCIPAL ASSISTANT ENGINEER (Co-ordination), to supervise engineers co-ordinating power station construction work in several Divisions. Duties include visits to power stations and attendance at site meetings. Practical experience in modern power station construction, including handling of contracts, preparation of commissioning programmes, work on site and co-ordination of projects from inception to commissioning is essential.

Candidates should preferably be Corporate Members of the I.E.E. (for " A ") and the I.Mech.E. or the I.E.E. (for " B "). Salaries will be within the provisional range £1300–£1575 inclusive.

Applications, stating age, qualifications, experience, present position and salary, to D. Moffat, Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, by December 5th, 1953. Quote reference E./430. E6162

HER MAJESTY'S COLONIAL SERVICE

LAND DEVELOPMENT UNIT, SINGAPORE

ENGINEER

Applications are invited for the following post :—ENGINEER, Drainage and Irrigation, Land Development Unit, Singapore.

Duties will include preparation of design and working drawings for permanent works for drainage and water control for swamp areas. Preparation of specifications, bills of quantities and contracts for the execution of reclamation and drainage works, either by contract or direct labour organisation and control of labour. Construction, maintenance and operation of reclamation and drainage and irrigation schemes.

Appointment is on contract for two years in the first instance.

The gross emoluments of the appointment are in the incremental range £1687 to £2730 p.a., depending on age and experience and marital status. In addition, a gratuity of £70 for each completed three months' period of satisfactory service on full pay is payable on satisfactory completion of contract. Candidates, who should be over 30 years of age, must hold a recognised University Degree or Diploma in Civil Engineering, carrying exemption from Sections I and II of the A.M.I.C.E. examinations, or be A.M.I.C.E. They must have had considerable experience of civil engineering construction, particularly with the use of earth-moving mechanical plant, or on the design and construction of reinforced concrete works.

Full details on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE 144/60/03. E6077

AIR MINISTRY

CLERK OF WORKS (CONSTRUCTION)

The Royal Air Force invites applications for posts as CLERK OF WORKS (CONSTRUCTION) in the R.A.F. Airfield Construction Trade Group in the ranks of Flight Sergeant and Warrant Officer. Initially, engagements are for five years' Regular and four years' Reserve Service, but all suitable men may re-engage to age 55 and qualify for a substantial pension and terminal grant. Basic weekly pay (exclusive of ration and clothing allowances and increments) is £7 10s. 6d. for a Flight Sergeant (£10 3s. if married), and £8 11s. 6d. for a Warrant Officer (£11 7s. 6d. if married).

Qualifications must include at least 10 years' experience in heavy civil engineering construction with (a) at least five years as general foreman or clerk of works, or (b) at least three years on estimating, costing and management with a contractor, followed by three years as site or general foreman. Preference will be given to candidates who are Associate Members of the Institution of Clerk of Works, but any applicants with comparable experience will be considered, including those with former service in H.M. Forces as clerk of works or equivalent.

Applications, with particulars of training, experience and qualifications, are to be addressed to Inspector of Recruiting, Royal Air Force (C.W.14), Victory House, Kingsway, London. W.C.2. E5925

PUBLIC APPOINTMENTS

CITY COUNCIL OF SINGAPORE

CITY ELECTRICAL ENGINEER'S DEPARTMENT

PASIR PANJANG POWER STATION

ASSISTANT RESIDENT MECHANICAL ENGINEER

Applications are invited for the post of ASSISTANT RESIDENT MECHANICAL ENGINEER for the Pasir Panjang Power Station, which is at present in operation with two 25MW turbo-alternators and two 187,500 lb. per hour boilers, 625 lb. per sq. in. pressure and 825 deg. F. superheat, and for which extensions are now in hand covering three 25MW turbo-alternators, five 187,500 lb. per hour boilers, and one 2MW gas turbine house set.

Applicants should be Corporate or Graduate Members of one of the Senior Engineering Institutions or possess equivalent qualifications, and have had a sound training in mechanical and electrical engineering with practical experience in steam power plant and ancillary equipment.

The appointment is for a two years' agreement, commencing in April, 1954, at a salary of 1450 dollars per month inclusive of transport allowance (1.00 dollar equals 2s. 4d.).

Free first-class return passages by normal route for the officer, his wife and children up to three full passages in all, provided no child exceeding the age of twelve years, will receive a passage.

Half salary from the date of leaving the United Kingdom to the arrival in Singapore and on the return voyage.

Vacation leave of 28 days after completion of two years' resident service to commence from the date of arrival in the United Kingdom, provided the return voyage does not exceed 26 days.

Rent of City Council quarters, if available, 50 dollars per month.

Applications, endorsed " Assistant Resident Mechanical Engineer," stating age, qualifications and experience, should be forwarded to the undersigned within 14 days of the date of this advertisement.

PREECE, CARDEW & RIDER,
Consulting Engineers.
8, 10 and 12, Queen Anne's Gate,
Westminster, London, S.W.1. E6036

HACKNEY BOROUGH COUNCIL

ASSISTANT ENGINEER AND ENGINEERING ASSISTANT

Hackney Borough Council require :

(i) ASSISTANT ENGINEER.

Grade A.P.T. V (A)–VI (£625–£735 p.a.), plus London weighting allowance.

Candidates must be chartered municipal engineers or have passed Sections A and B of the Associate Membership Examination of the Institute of Civil Engineers, and have wide experience in all branches of municipal engineering. Good knowledge of structural engineering would be an advantage.

(ii) ENGINEERING ASSISTANT.

Grades A.P.T. III–IV (£525–£600 p.a.), plus London weighting allowance. Candidates must have had good experience in general municipal engineering. Engineering qualification would be an advantage.

General conditions of appointment and application form from the undersigned on receipt of stamped, addressed, foolscap envelope.

Applications, endorsed " Assistant Engineer " or " Engineering Assistant," as appropriate, returnable by first post on the 7th December, 1953.

DUDLEY SORRELL,
Town Clerk.
Town Hall,
Hackney, E.8,
6th November, 1953. E6107

SUDAN GEZIRA BOARD

ASSISTANT EXPERIMENTAL ENGINEER

The Sudan Gezira Board invites applications for the post of ASSISTANT EXPERIMENTAL ENGINEER. Applicants should be not more than 25 years of age and single. They must have served a full apprenticeship, including draughtsmanship, with a recognised engineering firm and must be capable of developing schemes in full detail.

Starting salary would be in the region of £E.800 per annum, plus a cost-of-living allowance, which is reviewed quarterly. Appointment will be on short-term contract for a period of three to five years and a gratuity will be payable on termination of the contract. Outfit allowance and free passage on appointment. There is at present no income tax in the Sudan.

Terms of service and application forms will be sent on receipt of a postcard only, addressed to The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting " Asst. Experimental Engineer 2413," and name and address in block letters. E6073

MIDDLE LEVEL COMMISSIONERS

ASSISTANT ENGINEER

Applications are invited from suitably qualified Civil Engineers for the post of ASSISTANT ENGINEER, Grade V (£595–£645). The successful applicant will be engaged upon design of pumping stations and other structures associated with land drainage and a sound knowledge of reinforced concrete design, hydraulics and soil mechanics is necessary. The successful applicant will not be required to provide a car. The appointment is superannuated in accordance with the Local Government Superannuation Act, 1937. Appl cations, stating age, professional qualifications and experience, together with the names of three referees, and endorsed " Assistant Engineer," must be received by the undersigned not later than the 4th December, 1953.

L. F. FILLENHAM,
Chief Engineer.
Middle Level Offices,
March, Cambs. E6114

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

WORK STUDY BRANCH OF PRODUCTION DEPARTMENT

WORK STUDY ENGINEER

National Coal Board invite applications for a senior post of WORK STUDY ENGINEER in the Work Study Branch of Production Department at London Headquarters. The duties of the post will include general supervision of the application of work study in the Board's mines, co-ordination of the arrangements for training Area Work Study Engineers, and close liaison with them (through Divisions) in the development of work study in coal mining, with prospects of eventually taking full charge of the Headquarters Work Study Branch.

The present holder of the post will have completed his tour of duty during 1954. His successor, however, will be appointed to the Headquarters staff some time before the vacancy occurs, in order to take a planned course of training in work study, before taking over full responsibility.

Applicants, who must hold a First-Class Colliery Manager's Certificate, should have a good knowledge of modern mining methods and layouts and considerable experience in negotiating with labour. The successful candidate should be prepared to serve at the Headquarters of the National Coal Board for at least three and preferably five years. Though based in London, he will be expected to spend a good proportion of his time in the field.

The salary, which will be according to qualifications and experience and will be not less than £2000 per annum, will be paid from the date of appointment to the Headquarters staff.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/704. Original testimonials should not be forwarded. Closing date 4th December, 1953. E6091

HER MAJESTY'S COLONIAL SERVICE

NIGERIAN RAILWAY

ASSISTANT ENGINEERS AND ASSISTANT ENGINEERS (CAPITAL WORKS)

ASSISTANT ENGINEERS and ASSISTANT ENGINEERS (Capital Works), Nigerian Railway.

Appointment on probation for permanent and pensionable establishment, or on contract/gratuity terms. Basic salary £650 by £40 to £1290 for permanent appointment ; £713 by £44 to £1419 on contract. Expatriation pay, varying according to salary from £180 to £300 p.a. also payable.

Officers appointed on contract/gratuity terms also receive substantial gratuity on satisfactory completion of contract.

Candidates must hold a recognised University Degree or Diploma in Civil Engineering carrying exemption from Sections I and II of the A.M.I.C.E. examinations plus two years' approved practical experience, preferably in railway engineering, or be A.M.I.C.E.

Duties would include taking charge of engineering sections and work on bridges, general reinforced concrete construction, &c.

Further details on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE 110/14/06–09. E6130

METROPOLITAN WATER BOARD

APPOINTMENT OF WELL ENGINEER

There is a vacancy for a WELL ENGINEER on the permanent staff. Salary scale £778 to £1025 per annum by annual increments, commencing salary according to age, qualifications and experience. Maximum age 45 years. It is a condition of the appointment to and the holding of the position that the selected candidate shall be and continue to be a subscribing Corporate Member of the Institution of Civil Engineers.

Candidates should possess a sound knowledge of hydro-geology and have had responsible experience in well and borehole sinking and in the supply of water from wells.

A house may be available, if required, in a good neighbourhood, at an inclusive rental of £129 per annum.

Particulars of the appointment and a form of application may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope, quoting reference G.7, and completed applications must arrive not later than 14th December, 1953.

W. S. CHEVALIER,
Clerk of the Board.
Offices of the Board, New River Head, Rosebery Avenue, London, E.C.1. E6004

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION

RESEARCH ENGINEER

The Parsons and Marine Engineering Turbine Research and Development Association requires a RESEARCH ENGINEER for experimental development work on gas turbines. Applicants should have an Honours Degree in Engineering and experience on running machinery. Gas turbine experience is not essential, but an aerodynamic background would be an advantage. A good salary will be paid, depending on age, qualifications and experience.—Candidates should apply in writing to the Research Director, Pamstrada Research Station, Wallsend. E5996

THE ENGINEER

NOVEMBER 20, 1953

Association of Consulting Engineers

ON Friday last, November 13th, the Association of Consulting Engineers held a luncheon at the Dorchester Hotel, London, to commemorate the fortieth anniversary of its inauguration. Discussions about the function of the Association were started in 1908, but it was not until 1913 that the Articles of Association were finally signed, the Association then having eighty members. Its first chairman was Mr. C. Midgley Taylor, whose firm is now carried on as John Taylor and Sons. In the early part of the century the meaning of the term "consulting engineer" was not clearly defined, and on its formation the Association drew up a strict code of conduct, based largely on that of the Institution of Civil Engineers, which is in force to-day with only small modifications. The membership of the Association now numbers 370. At the luncheon the toast of "The Association" was proposed by Mr. Maudling, Economic Secretary to the Treasury, and Sir Bruce White responded. The toast of "The Guests" was proposed by Mr. G. M. C. Taylor, the son of the first chairman, and Sir Albert Braithwaite, chairman of the Export Group for the Construction Industries, replied. The general tenor of the speeches emphasised one of the principal problems facing the consulting engineer to-day, namely, that of obtaining more work abroad. Mr. Maudling pointed out the importance of such work and the way it encouraged subsequent export trade, and he said that the Government was anxious that consulting engineers should do all they could to help exports in this way, but without impairing their professional integrity. In his reply, Sir Bruce White noted that the problem of competition from other countries, where the consultant and contractor relationship was not the same, had been discussed by the Association and the Export Group for the Construction Industries.

James Watt Monument at Greenock

AN appeal is being made for funds for repairing and maintaining the fabric of the James Watt Monument at Greenock. James Watt, it will be recalled, was born in Greenock in 1736, and the monument is a handsome building which was erected to his memory in 1835. The architect was Sir Edward Blore, and one of the chief purposes of the undertaking was to provide a fitting setting for Chantrey's statue of James Watt, for which the people of Greenock subscribed £2000. A large part of the cost of the building was met by the inventor's son, the younger James Watt. Through the years, the Watt monument has served as the centre for the cultural life of Greenock, and within it there has been housed the Greenock library which to-day contains over 60,000 volumes. During the last visit that he made to his birthplace, in 1816, James Watt made a gift of £100 to the Greenock library. His wish was that the money should be "laid out in books which shall treat of natural philosophy and mathematics, and more especially on geometry, mechanics, astronomy, navigation, the motion, resistance and other properties of fluids, statics and the science and art of shipbuilding." For 118 years, the Greenock library committee has looked after the Watt monument and has had to depend on members' subscriptions, there being no endowment fund. Now, immediate repairs to the building are necessary, the minimum sum required for them and for future upkeep being put at £25,000. An appeal fund committee has been set up and invites donations not merely from the citizens of Greenock, but also from "all those who have prospered by the inventions of James Watt, and all who care for the great traditions of engineering." Donations should be sent to Mr. George Morrison, chairman of the James Watt Monument Appeal Fund, c/o Clydesdale and North of Scotland Bank, Ltd., 134, Cathcart Street, Greenock.

BEAMA Dinner

THE British Electrical and Allied Manufacturers' Association held a dinner at Grosvenor House, London, on Monday, November 16th, under the chairmanship of Sir Harry Railing, the president of the Association. After the loyal toast had been honoured the Rt. Hon. Duncan Sandys, M.P., the Minister of Supply, proposed the toast of the electrical industry. Mr. Sandys spoke of the rapid progress made by the industry in its short history since 1878, when the first metal filament lamp had been made by Swan in Britain and Edison in America. To-day, the electricity industry was a direct servant of the housewife and the industrialist—and the Chancellor of the Exchequer, for, said Mr. Sandys, electrical exports in 1952 paid for one-sixteenth of Britain's imports of food and raw materials. The value of the output of electrical plant and equipment had increased from £300 million in 1946 to £700 million in 1952, and the value of electrical exports over the same period had risen from £60,000,000 to £200 million. Referring to the industrial applications of atomic energy, Mr. Sandys said that work had been started on the first atomic power station in Cumberland. He also said that it was hoped to start work soon on the first breeder reactor for electricity generation. It may be recalled that Mr. Sandys had made a statement in the House of Commons earlier the same day to the effect that design and planning work on the breeder reactor was already far advanced, that a number of sites had been considered in various parts of the United Kingdom, and that one of these sites was in Scotland. In responding to the toast of the electrical industry, Sir Harry Railing said that the main activities of BEAMA were the laying down of standards of quality, the development of co-operative research through the E.R.A. and through the research laboratories of individual member firms. The Association had also played a leading part in the laying down of contract conditions and guarantees fair to producers and customers in all parts of the world. The BEAMA education committee was formed before that of any other industry. The result, Sir Harry said, was that the Association had built up an industry which was independent in research, development and production. That industry employed 600,000 workers and had been built up with an eye to the whole edifice, not with an eye to one year's profit or to the profit on a particular size of wire or lamp or turbo-generator. The toast of "The Guests" was proposed by Mr. D. D. Walker, chairman of the BEAMA council, and the response was made by the Rt. Hon. H. U. Willink, Vice-Chancellor of the University of Cambridge.

Road Expenditure

THE Grand Council of the Federation of British Industries has sent a report on the condition of Britain's roads to the Chancellor of the Exchequer. The report points out that the state of the roads is of vital importance to every inhabitant, and that the roads are the most congested of any country in the world. In the Federation's opinion the requirements of the roads for capital expenditure can no longer be disregarded. An estimate of the annual loss to the country caused by inadequate roads is given in the report as £60,000,000, based on 1946 prices, made up of loss of time and fuel, tyres and vehicle repairs and accidents. The total cost of the 76-mile motorway from Bristol to Birmingham would be about £11,500,000, it is stated, giving estimated savings to road users of about £1,000,000, and a substantial margin after meeting all costs over twenty-five years. There is little doubt, the Federation states, as to the economic justification of this and many other projects for which similar calculations could be made. The report recommends that the Government should reconsider priorities for new capital expenditure and for the allocation of raw materials, and give a much higher priority to the construction of modern motorways and the development of existing roads. It is believed, the report states, that an expenditure of from £20,000,000 to £50,000,000 per annum (over a period of, say, five years), in addition to present expenditure on roads, should be authorised forthwith and should be keyed to those plans known to exist already which are considered to have the highest priority. Such expenditure would represent a modest beginning and operations could be extended later when circumstances permit. The method of financing is a matter for decision by the Government, the report points out, but the Federation considers that, if the funds initially made available were insufficient for the rapid expansion of the roadway system, industry would not be averse to meeting part of the cost by a limited application of tolls to special sections of new motorways, tunnels or bridges, particularly where the use of these facilities would substantially reduce the distance between points and in consequence save time and money.

Cycle and Motor-Cycle Show

LAST Saturday the Cycle and Motor-Cycle Show, the twenty-eighth organised by the British Cycle and Motor-Cycle Manufacturers and Traders' Union, was opened at Earls Court. At this exhibition much interest has centred in recent years on the motorised bicycle. In this country this form of transport has not become as popular as it has on the Continent, largely, it is thought, because of the licensing and insuring considerations which are involved with these vehicles here Neither in the slightly heavier class has the scooter made great headway against the more British conception of a small motor-cycle. Apart from the two foreign designs already being made in this country, however, a new scooter is being shown. It has a plastic body on a tubular frame and incorporates several distinct advantages in the suspension and drive adopted; much larger wheels are used. There are seven makers exhibiting auxiliary engines for bicycles. Two British-designed units are being shown for the first time. One, the B.S.A. "winged wheel," is a two-stroke engine of 35 c.c. capacity and is self-contained within the rear wheel hub, which also embodies a large internal expanding brake. The other engine is rated at 48 c.c. capacity and is suspended from the bottom bracket, the drive being by friction roller. Both units are designed for attachment to standard pedal cycles and in the latter case a front fork reinforcement member has been designed. The desirability of a stronger frame, specifically designed for the higher road speeds of these machines, is recognised by several frame manufacturers, and a number of machines in this category are shown. The divergence of motor-cycles into two distinct categories is more apparent this year: the really high-performance luxury machine of over 500 c.c. and the economical lightweight of under 250 c.c. capacity. In this latter class those of 125 c.c. capacity have proved more popular, but this year the show indicates renewed interest in motor-cycles of the 200/250 c.c. class.

Hydro-Electric Development in Portugal

No. IV—VILA NOVA POWER STATION

(*Concluded from page* 617, *November* 13*th*)

In the preceding articles, Nos. I–III, we dealt with the 172·7*MVA Castelo do Bode power station on the River Zezere. Another important development, the Vila Nova power station on the River Cavado, is described here. It houses three impulse-turbine generators, each rated at* 32*MVA under a gross head of* 1300*ft. The output is transmitted to Oporto by a* 150*kV feeder. There is also a* 30*kV feeder from Ermal and provision is made for a second* 150*kV feeder.*

FROM the plan and profile in Fig. 21 it will be seen that the dam at Venda Nova on the River Rabagao is about 4km (2½ miles) from the power station at Vila Nova, the turbines of which discharge into the River Cavado. The dam is 97m (318ft) high and the water which it impounds is conveyed to the power station by a tunnel and steel pipeline. When the dam at Paradela (near the confluence of the rivers Pitoes and Cavado) is completed a further tunnel will be driven connecting the reservoir so formed with Vila Nova, thus enabling the installed capacity of this station to be increased by 60MVA. At present Vila Nova is equipped with three units having a total capacity of 96MVA. At the Venda Nova dam a diffusing disperser valve is installed, similar in design to those on the scour culverts at Castelo do Bode. It is 2·6m (8ft 6in) in diameter, designed for hand and electrical operation, and is capable of discharging 120 cubic metres (423 cubic feet) of water per second under 100m (328ft) head.

At the Vila Nova end of the tunnel there is a portal valve of the self-closing, "Straight Flow" design, 2·13m (7ft) bore. This valve is operated by the action of water pressure and is generally similar to the corresponding valves described in connection with Castelo do Bode. It is provided with a paddle trip for emergency closing, consisting of a gun-metal rod suspended in the waterway. From this valve the pipeline, which is about 854m (2800ft) long, descends the hill to the distributing piping and thence to the turbines.

The pipeline is in three main sections, 2·40m (7ft 10½in), 2·26m (7ft 5in) and 2·1m (6ft 11in) outside diameter with a thickness varying from 19mm (¾in) to 51mm (2in). It is made of mild steel and the pipes and bends were welded together on site and afterwards tested at a pressure equal to 175 per cent of the static head. The distributing piping passes along the side of the power station with branches to the turbine inlet valves. Within this piping there is an isolating "Straight Flow" valve 1·2m (47¼in) bore, which combines compactness with smooth bore flow which is important because of the high velocity at this point. There are six turbine inlet valves, two for each of the three twin turbines, and they, too, are "Straight Flow" equipments. They are 825mm (32½in) bore and, because of the high head, have been made of cast steel. Fig. 22 is a view of the station showing the pipeline and the further track which is available for another pipeline when the Paradela extension comes into operation.

Arrangement of Power Station

A plan of part of the station arrangement is given in Fig. 23, and Fig. 24 is a view of the machine room. The main generating units are installed down the centre. On the downstream wall, opposite each unit, are motor-driven exciter sets and their control boards. On the upstream side are the valve control cubicles, the governor oil pressure pumping sets, the bearing oil pumping sets and the gauge panels. A turbine-driven auxiliary generating set is placed at one end of the station and space is left for a further auxiliary set at a future date. The main valves are below floor level, covered by chequer plating which can be removed for crane access.

At one end of the station is the control room, which overlooks the machine hall, and on the upstream side are the 11kV and 33kV switchgear rooms and the cable galleries. The 165kV switchgear is on a level with the roof of the power station, slightly upstream, and against the steep slope of the hillside (Fig. 22).

Controls.—The sets are started up and shut down manually, but full control is centralised in the control room. Synchronising takes place automatically when voltage and synchronism have been correctly adjusted.

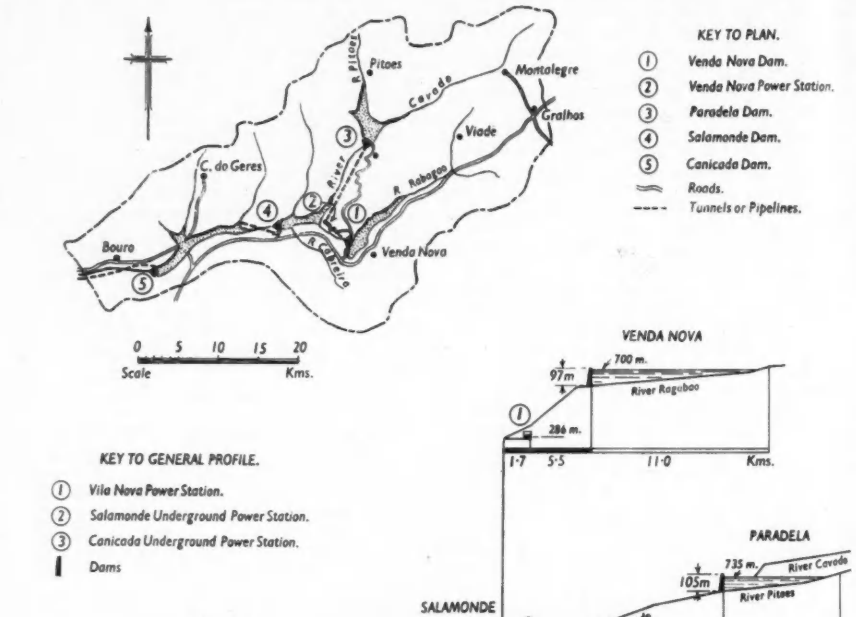

Fig. 21—Plan and Profile of River Cavado Development

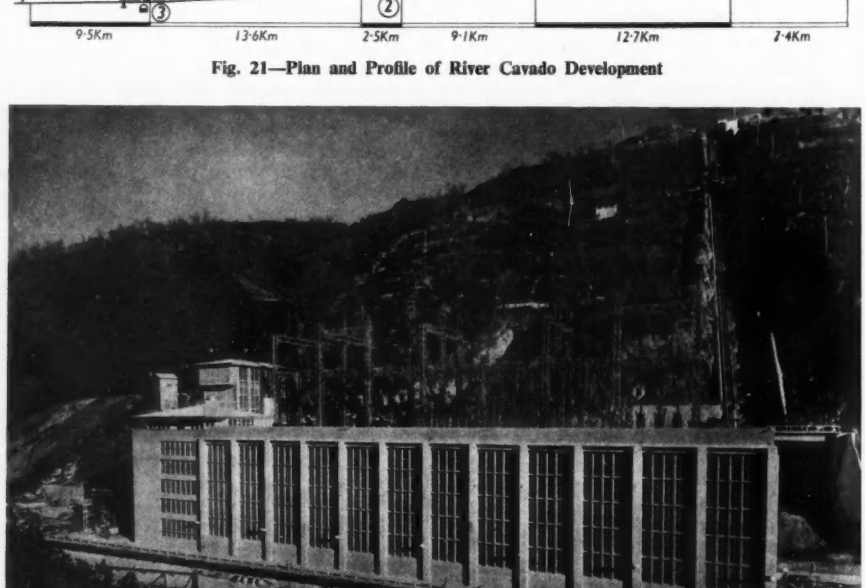

Fig. 22—Vila Nova Power Station

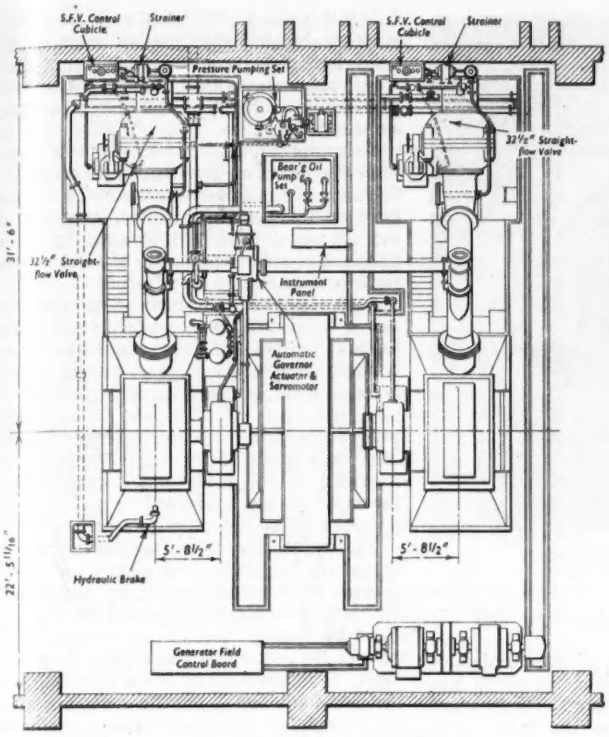

Fig. 23—Vila Nova Power Station Arrangement—Plan

Fig. 24—Vila Nova Power Station Machine Room

Generating Plant

Turbines.—Because of the higher head, the three turbines at Vila Nova (Figs. 24 and 25) are very different from those at Castelo do Bode. They are horizontal shaft, four-jet impulse turbines with twin runners, one overhung at each end of the generator shaft, and each actuated by two jets. Under a gross head of 395m (1300ft) each turbine is rated at 36,000 h.p. and under a maximum gross head of 415m (1360ft) each turbine will give 39,000 h.p. The normal speed is 428 r.p.m. and the machines are designed to withstand a runaway speed of 792 r.p.m. under the maximum head.

The runners are of stainless steel cast in one piece, that is, with integral buckets. The casings are fabricated and each turbine has two inlet bends, each of which is equipped with a nozzle, spear and the jet disperser of the "Seewer" governing device. Within the spearhead there are a number of slanting streamline guide vanes, normally withdrawn into the head, and controlled by the governor by means of a distributing valve and an oil pressure servo motor. When a sudden drop in load occurs, the vanes are projected into the water stream and diffuse the jet, thus destroying the energy imparted to the buckets of the runner. This device ensures sensitive high-speed governing because little energy is required for introducing it into the jet, which is diffused very rapidly. In Fig. 26 we reproduce a photograph of a model of one of the turbines with its inlet valve; it will be noted that the diffusing vanes are shown projecting from the spearhead.

A system of hydraulic braking enables the set to be brought rapidly to rest: water under pressure is tapped from upstream of the inlet valve and made to impinge on the backs of the buckets through a nozzle mouthpiece and control valve. This device can also be seen in Fig. 26.

Governing is by automatic oil pressure equipment with an actuator similar to that at Castelo do Bode. In this case however, the governor pendulum has a mechanical drive consisting of a spur and bevel-gear drive connecting the turbine shaft with the governor head by a shaft into which a flexible stainless steel plate has been inserted. This plate provides a combination of rigidity and flexibility and thus eliminates vibration and the detrimental effect of temperature changes. The gear drive operates entirely in an oil bath.

Safety gear is provided to shut down the turbine by the operation of the diffuser in the event of governor drive failure, underspeed and oil pressure falling below a certain figure. As already mentioned, there are six valves for the three twin turbines. Each valve has one servo motor and operation is by water pressure. Despite the high pressure due to the head, both the service seals and the emergency isolating seal incorporate rubber as the staunching medium, which is adjustable to give complete drop tightness.

The turbine of the auxiliary generating set is a horizontal-shaft impulse machine, overhung at one end of the generator shaft and actuated by one jet. It is rated at 1150 h.p. under 365m (1200ft) gross head and 1300 h.p. under 415m (1360ft) gross head and runs at 1000 r.p.m. It has a cast steel runner with integral buckets and an automatic oil pressure governing system.

Generators.—The generators are horizontal machines having a rated output of 32MVA (25·600MW) at 0·8 lagging power factor, 11kV, three-phase, 50 c/s. They are connected through step-up transformers to the 165kV transmission system and are capable of an output of 20MVA at zero leading power factor for line charging. The main and pilot exciters are separately driven by an induction motor supplied through unit trans-

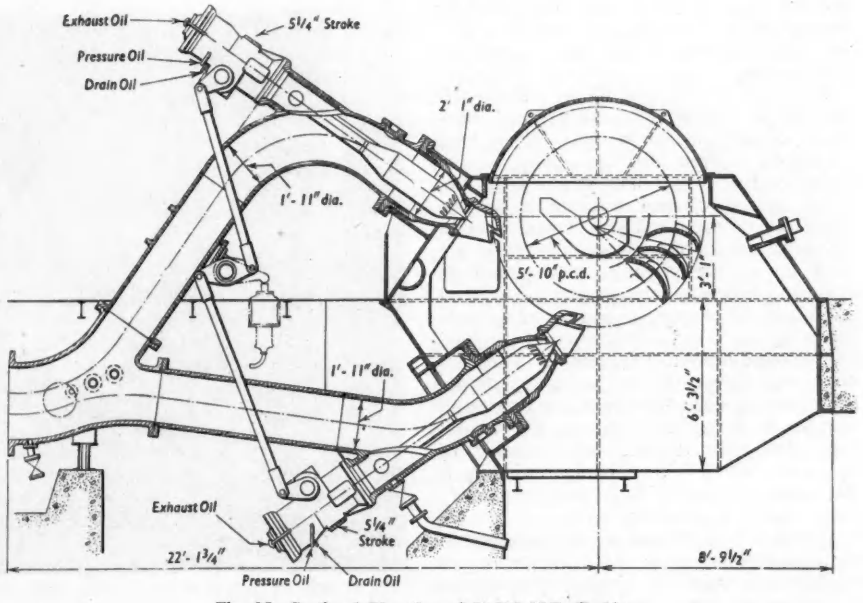

Fig. 25—Sectional Elevation of 39,000 H.P. Turbine

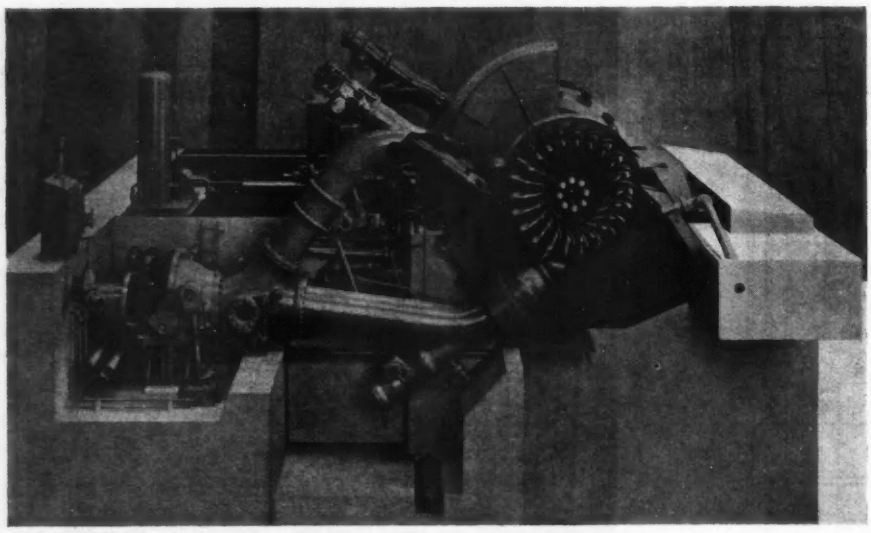

Fig. 26—Model of 39,000 H.P. Turbine

formers from the generator terminals. During the running-up period the driving motor supply is obtained from the station common services board, which in turn is energised from the 875kVA, 0·8 power factor, 1000 r.p.m. station auxiliary set or, in an emergency, from a source external to the station via auxiliary transformers provided for this purpose.

The main generators are of conventional design with two pedestal bearings, and an enclosed ventilation system with water-cooled air coolers mounted in the generator pit and constructed in four units to reduce withdrawal space. Although the normal running speed is 428 r.p.m., the generators are designed to withstand the stresses produced at the turbine runaway speed of 792 r.p.m.

The stator frame, which is of welded steel construction and split into two halves to facilitate transport, houses a silicon alloy laminated core clamped between heavy steel end-plates. Open slots on the inner periphery of the core accommodate the class B insulated stator winding, which is of the diamond pulled type. The separate coils of the winding are duplicate and interchangeable. They are continuously taped from end to end with mica silk tape and vacuum dried and impregnated under pressure. Adequate bracing of the winding is provided to prevent distortion due to the heavy forces on short circuit.

The flywheel effect ($2{\cdot}09 \times 10^6$ lb ft^2) required to ensure satisfactory speed regulation of the turbine under varying load conditions is provided inherently in the generator rotor (Fig. 27). It is a solid disc rotor with tee-shaped projections on the poles keyed into similarly shaped slots in the periphery of the discs. The poles are built up of heavy gauge steel stampings clamped between semi-circular cast steel end plates. The overhanging tip of the pole punchings and end-plates support the field coils around the whole periphery. The field coils are former-wound of bare copper strap bent on edge, the size of the straps and number of turns being chosen to give full load flux with an excitation voltage of approximately 300V. A damper winding is provided in the pole faces and completely interconnected between poles.

For the measurement of temperature in the generators there are thermocouples for the stator winding, a special temperature indicator for the rotor winding and dial thermometers for the bearings and air circuit.

The exciter set consists of main and pilot exciters and a flywheel driven by a 170 h.p. induction motor at 1494 r.p.m. The flywheel is provided to smooth out the field-forcing peaks and to provide the stored energy for maintaining the excitation should the generator voltage and hence the driving motor supply voltage collapse under fault conditions. The exciter set is mounted on a bedplate and is transportable as a unit. A complete exciter set is provided as a spare so that it can easily be moved to replace any set which may require dismantling for inspection or maintenance.

The common services board is normally supplied from an impulse turbine-driven auxiliary set running at a normal speed of 1000 r.p.m. and designed to withstand the stresses that may occur at the turbine runaway speed of 1900 r.p.m. To provide the inertia required for satisfactory governing, the inherent flywheel effect of the generator is augmented by a flywheel mounted next to the generator between the two bearings. This generator has a solid cast steel rotor, the poles and rotor body being cast in one piece. The field coils are held in position by the overhanging edge of the solid bolted-on pole tips and are formed from copper straps bent on edge. The stator winding is of diamond coils placed in open slots in the core.

Generator Transformers.—A direct-connected group of main transformers is installed for each of the three generators. Transport between the port of entry in Portugal and the site was difficult and, to meet the limitations, three-phase groups of single-phase transformers had to be adopted.

Each 30MVA, three-phase group comprises three 10MVA, single-phase transformers, connected delta on the lower voltage windings and star on the higher voltage windings for a voltage ratio at full load, 0·85 p.f., of 11/165kV. The neutral point of the 165kV windings is solidly earthed. Plus and minus 5 per cent tappings are provided on the high-voltage windings and the tappings are connected to an externally operated off-circuit tapping switch.

The transformer losses are dissipated with forced oil circulation through water-cooled coolers. An oil pump and cooler are installed for each three-phase group and 100 per cent stand-by pump and cooler capacity is provided. Transfer is made by valve adjustment. The cooler circuits are complete with the usual oil and water flow alarms. The total weight of each single-phase transformer is 35 tons ; stripped for transport the weight is 23·5 tons.

Switchgear

11kV Connections.—Each of the three 32MVA generators is connected solidly to its main 11/165kV step-up transformer with a tee-off to its 11,000/380V. unit transformer These connections take the form of bare copper conductors having a rating of 2000A and mounted on post insulators with suitable phase barriers running through horizontal and vertical ducting to the 11kV switchgear on the fourth floor of the power-house. To give greater flexibility for emergency and maintenance purposes, transfer busbars run on the wall above the switchgear for the whole length of this floor and selector links enable any generator to be connected to any main transformer bank or to be loaded on to a water resistance test tank of adequate capacity. The control and protective cir-

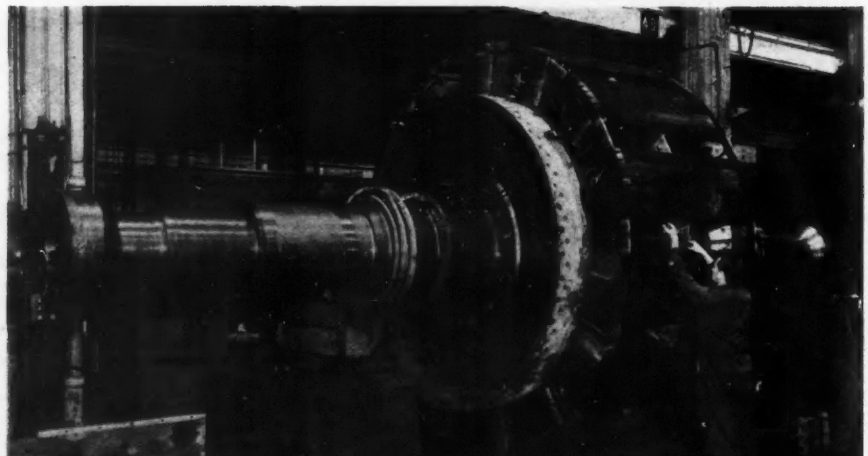

Fig. 27—Rotor of 32MVA Generators During Manufacture

cuits are provided with similar links to ensure correct operation under all conditions. Each switchgear equipment associated with a generator contains the above-mentioned selector links for the main circuit, isolator links for unit transformer, instrument transformers for protective circuits and metering duty and, together with the unit transformers themselves, are enclosed by expanded metal screenwork on three sides, with the wall at the rear.

The main 11kV circuits are connected through roof bushings to the low voltage sides of the respective transformer groups and, where delta connections are made, consist of bare copper supported by outdoor post insulators on steel pipe framework.

165kV Outdoor Substation.—Situated on a level with the fifth floor is the substation, consisting initially of three generator circuits, bus coupler and outgoing feeder to Oporto with space for one future generator and one future feeder (Fig. 28) and all arranged in line abreast. Construction is of high level design (Fig. 30) with the duplicate busbars arranged side by side at a height of 63ft and comprising stranded copper conductors suspended between strain insulators. Busbar selector isolators, arranged for off-load operation by electrical interlocks, are mounted below the busbars and connected back-to-back by copper-clad steel tubes, supported by post insulators. Feeder isolators are provided with mechanically interlocked earthing contacts, and all isolators are local mechanically controlled and electrically interlocked with the respective circuit breakers. The supporting structures are of galvanised steel to a maximum height of 80ft, the outgoing feeder transmission line to Oporto spanning the Cavado River.

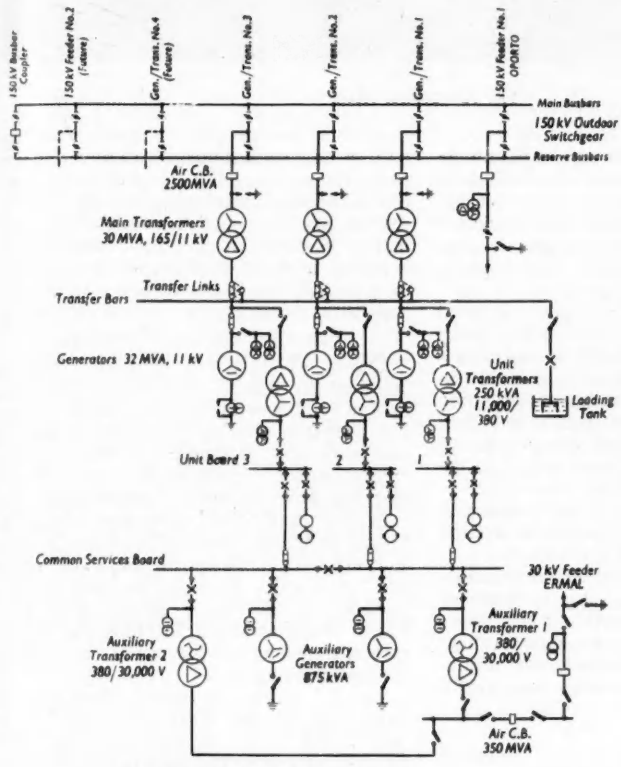

Fig. 28—Cavado Substation Key Diagram

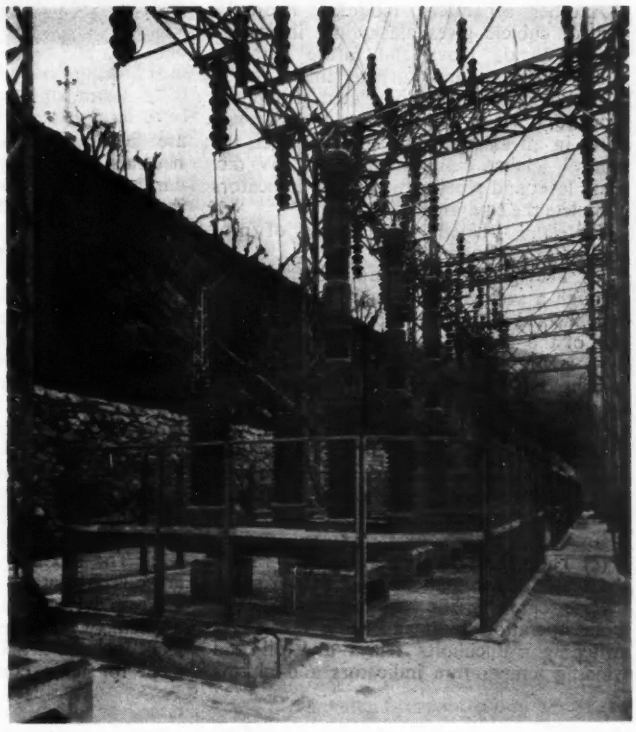

Fig. 29—165kV Air-Blast Circuit Breakers at Vila Nova Substation

165kV Circuit Breakers.—These circuit breakers (Fig. 29) are air-blast equipments, each rated at 600A and having a rupturing capacity of 2500MVA at 165kV. Three interrupter units are used in series, per phase, mounted to form a single vertical column immediately above the housing containing the operating cylinders for the sequence making switch which operates in the vertical plane. Each interrupter unit is shunted by a non-linear resistance for suppression of switching over-voltages and to ensure effective voltage division. The speed of operation from trip impulse to arc extinction is of the order of three cycles.

Current transformers are included as an integral part of the circuit breakers; they are oil-immersed, cross-coil, porcelain-clad wound units, with multiple cores and secondaries as required for the various duties. The Oporto feeder breaker is equipped for single-phase and three-phase, high-speed, single-shot, auto reclosure, with "dead time" adjustable from 20 to 60 and 10 to 20 cycles respectively. Relay equipment and selector control are mounted in the main control room.

Compressor Equipment.—The plant for the operation of the circuit breakers is housed on the floor immediately below the outdoor substation and is of adequate capacity for the planned extensions. Two main storage vessels are provided, each fitted with duplicate compressors, automatically operated by rise and fall of pressure. The vessels are interconnected and all pipework duplicated for ease of repair and maintenance. These vessels store air at 600 lb per square inch, which is expanded to 300 lb per square inch, through reducing valves to the bus piping systems, thereby obtaining the necessary dryness before operating the switchgear. Feeds from the system are also taken to the 30kV switchgear and turbine governor through suitable reducing valves at a pressure of 250 lb per square inch.

30kV Switchgear.—For bringing in a separate 30kV supply from Ermal, and also for supplying power to the local settlement and valve houses at the dams, the scheme includes two 33kV, 400A air-blast circuit breakers similar in principle to the 165kV breakers but having only one interrupter unit per phase and a rupturing capacity of 350MVA at 33kV. These circuit breakers, together with associated isolator gear, insulators, current transformers, &c., are mounted in stonework cells, having expanded metal screenwork and doors suitably interlocked. Two feeds are also taken to the auxiliary transformers for interconnection with the common services board. Remote control, indications and relay equipment are in the control room.

Station and Unit Auxiliaries.—Generation is at 380V, three-phase, three-wire, independent of any external source. The common services board is of single busbar construction and comprises remotely operated 25MVA air circuit breakers rated between 600–1600A, according to duty for auxiliary generators, bus section and auxiliary transformer circuits. Provision is made for two auxiliary generator circuits, although initially one impulse-turbine-driven 875kVA auxiliary generator only is connected, the bus section switch being closed. Extensions to the left and right are of high rupturing capacity, ironclad combination fuse switchgear, for station supplies which are as far as possible duplicated. Lighting supplies are taken from this board to three-wire/four-wire transformers to reduce fault capacity and also to avoid having a four-wire system throughout.

The unit boards are of similar composition to the above, and provide power for duplicate generator lubricating oil pumps, transformer oil pumps and separately driven exciter set associated with each main generator. The circuit breakers take the feed from the unit transformer and they provide an interconnection with the common services board above.

Control Room.—The main control board (Fig. 31) consists of vertical sheet steel cubicles arranged on three sides of a rectangle with the 165kV section and unit auxiliary control in the centre, the 30kV and 380kV sections being mounted on either side. Each

control panel has its circuit mimic diagram with illuminated semaphore indicators and illuminated circuit labels. The centre panel of the 165kV section comprises a central alarms annunciator with telephonic relays, above which are mounted the "comparator" dials of the master frequency equipment. There are two swinging synchronising panels, one being used for 165kV switchgear only and the other for the 30kV and 380V switchgear, check synchronising facilities being included.

A seven-panel desk control board of sheet steel construction is positioned centrally and includes control of the water resistance test tank and future main and auxiliary sets. The relay, metering and automatic voltage regulator cubicles are also of similar construction and are suitably placed in the control room with respect to the various boards.

Another separately mounted hydraulic control cubicle gives alarm and indication of the Venda Nova and future Paradela dams, pipelines and turbine inlets, on a mimic diagram with illuminated semaphore indicators. It is also possible to close any valve in an emergency from this panel, the control scheme being supplied at 24V d.c. Dam level and pipeline water flow indicators complete the equipment.

Protection.—Briefly the scheme of protection is as follows :—

(*a*) The generator neutrals are earthed through a voltage transformer across which is connected a surge arrester. The secondary side of the voltage transformer is connected to a relay insensitive to predominant harmonics, the operation of which causes the set to shut down.

(*b*) The main generator is provided with instantaneous circulating current protection, with inverse back-up overcurrent from current transformers in the star connections, and over-voltage protection. A rotor earth fault alarm is provided.

(*c*) The main transformer protection is by the biased differential method with a slight inverse characteristic to ensure immunity from operation by magnetising in-rush at switching. Buchholtz relays and oil and winding temperature indicators and alarms are fitted. The transformer high-voltage neutrals are solidly earthed and include a current transformer for operation of an induction relay with inverse characteristics. The 165kV station surge arresters are connected as near as possible to the outgoing terminals.

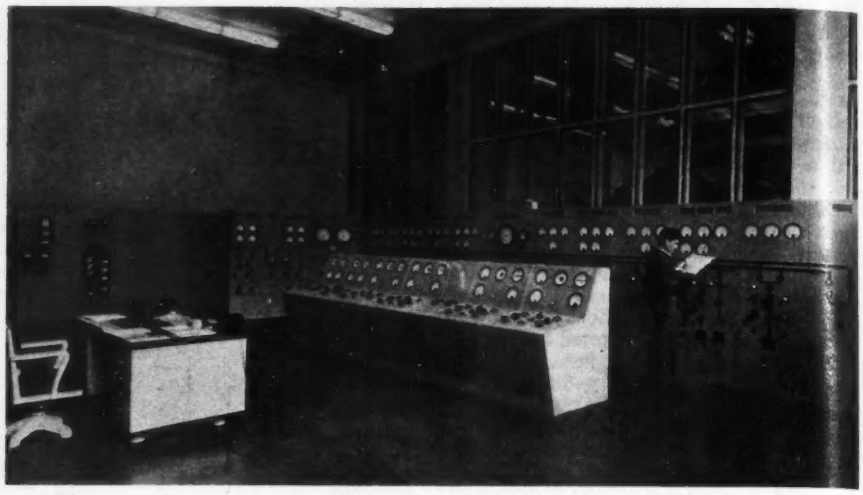

Fig. 31—Control Room

(*d*) The 165kV feeder to Oporto is fitted with induction back-up over-current relay only, by the British Group. Impedance relays which are suitable for single and three-phase auto reclose were the subject of a separate contract ; these protective relays, however, were mounted and wired on panels provided by the British Group as part of the main switchgear contract.

(*e*) The unit transformers are fitted with high-voltage inverse over-current protection and low-voltage balanced earth fault.

(*f*) The auxiliary generators have instantaneous circulating current relays with inverse back-up over-current protection.

Ancillary Equipment.—Ancillary equipment includes a 230V station battery equipment for main control circuits and a 24V battery for semaphores, hydraulic control panel, master frequency equipment and automatic telephone exchange, all supplied by the British Group. A suitable flat-back battery distribution board is supplied, on which is mounted a change-over contactor to give 230V d.c. emergency illumination supply in the occurrence of mains failure.

General Station Equipment

Cranes.—The power station crane is designed to handle a maximum working load of 110 tons and has the motions of main and auxiliary hoisting (25 tons), traversing and travelling, operated by four electric motors. Automatic electric brakes and upright reversing drum controllers are provided.

In the transformer workshop there is a 35-ton travelling crane with motions of main and auxiliary hoisting (5 tons), travelling and traversing, operated by four electric motors. In the valve house there is a 40-ton crane arranged for hoisting at two speeds, travelling and traversing ; it is operated by three motors.

Aerofoil Flow Recorders.—An aerofoil water flow recorder is installed in the pipeline for flow indicating and recording. The aerofoil assumes a different angle of incidence for varying rates of flow and is constrained by a simple coil spring. An extension of the pivoting shaft operates the indicating and recording apparatus.

There are also a dam water level indicator, cooling water pumps and piping for generator and transformer cooling water, purifying and testing equipment for turbine, generator and transformer oil, and sprinkler fire-fighting equipment.

Principal Manufacturers

The principal manufacturers of the plant and equipment for the Vila Nova power station contract were as follows :—

Main and auxiliary water turbines and turbine inlet valves, the English Electric Company, Ltd. ; main and auxiliary generators and main, auxiliary and lighting transformers, Metropolitan-Vickers Electrical Company, Ltd. ; power station and sub-station switchgear and control gear, disperser valve, portal valve and isolating valve, water-flow measuring equipment, the English Electric Company, Ltd. ; pipelines and distributing piping, the South Durham Steel and Iron Company, Ltd. ; power station, workshop and valve house cranes, Sir William Arrol and Co., Ltd. ; oil purifying equipment, Alfa Laval Company and Streamline Filters Ltd. ; "Mulsifyre" fire-fighting equipment, Mather and Platt, Ltd.

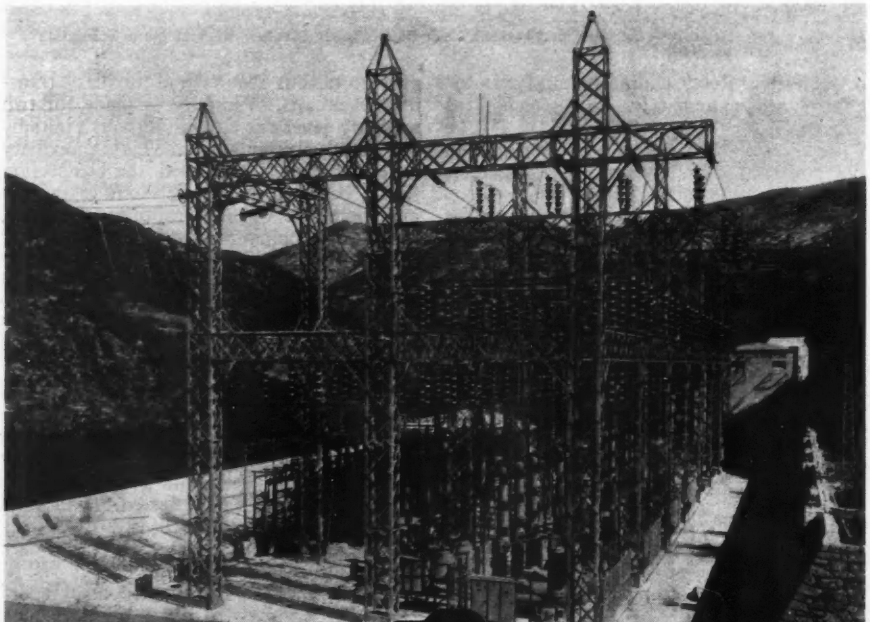

Fig. 30—Vila Nova 165kV Outdoor Substation

Steel-Making Processes

By JAMES MITCHELL, C.B.E.*

In this, the fourth, Dorman Long Harold Wright Lecture, delivered before the Cleveland Scientific and Technical Institution at Middlesbrough on November 12th, the author discusses, critically, modern trends in methods of producing steel. He suggests that there is a case for the multiplication of units such as blast-furnaces and steel furnaces rather than for an increase in unit size ; and stresses that the basic Bessemer process should be given more serious consideration as an alternative steel-making method to the basic open hearth. Pre-refining and duplexing methods for intermediate phosphorus irons are critically discussed.

WHAT determines the combination of plant and process which should be properly employed for any given set of conditions ? It is accepted that the ultimate basis must be one of economics, but the methods by which the lower production cost is attained offer, as we know, a wonderful variety of combinations of process and practice. It happens, too, that, in the course of time, alterations in the basic circumstances may lead to work being carried on with plant and equipment which would not be normally employed if one were starting *de novo*. It is very often under circumstances such as these, indeed, that the best technical work is being done with financial results which may be passable without being a just reward for the technical effort expended. I am sure we would all agree, for example, that, in most cases the British steel-maker has to work much harder and do much more in the transition from ore to ingot than, for instance, his American colleagues, or, to take an example nearer home, steel-making units based on their own blast-furnace plant, especially on low-grade ores, have to expend much greater effort than their fellows whose practice in steel-making is based primarily on high scrap/iron ratios. It may be pointed out that, even so, the total materials handled is greater on the 1000-ton per day furnace. This may be so, but it does not follows that, with certain burdens and more particularly cokes, the return for operative effort would be favourable.

Assessment of Productivity

We hear a lot to-day of productivity " per man " and " per unit." A much more just way of looking at the facts of the case would be to have, if it were practicable, a formula which would represent effort expended per ton of steel produced. The 1000-ton per day blast-furnace which handles a rich ore and consequently runs at a low coke rate is doing much less, in fact, in the way of productive effort than a 500-ton per day blast-furnace running on a low-grade ore with high slag volumes and consequent high coke rates. The one producer is perhaps handling something under 3 tons of material per ton of iron against the 4 tons to 4·5 tons required by his less fortunate neighbour. The worst possible basis for a study of productivity, to my mind, is through the medium of arithmetic. The recent report of the Iron and Steel Productivity Committee, for instance, recommended not less than 25ft hearth blast-furnaces for rich ores and 27ft hearth blast-furnaces for poorer material ; but, before adopting such recommendations, it is surely necessary to know whether, in fact, this approach would give the best ultimate economic results. There is a case for the multiplication of units rather than for the increase in unit size, and there are many plants where flexibility of operation can be shown to yield such large dividends that an approach based exclusively on productivity and capital costs is not necessarily correct. I have mentioned blast-furnaces particularly, but similar remarks apply also to steel furnace units, and in this case an additional consideration arises. The size of a steel-making unit cannot be determined without regard being paid to the nature of the final product required, both with respect to dimension and quality, whilst the mill practice which is to follow the steel-making is an essential part of the general picture.

The theoretical ideal in iron and steel-making, as in so many other things, is seldom attainable, but much can be done by intelligent analyses to eliminate something of the unbalance which frequently upsets operation of existing plants. I would not have you think that my intention is to deal exclusively with planning rules for new plants. We must consider, too, how far we can modify existing plant and practices to secure improved operation and enhanced economic return. The basis of this consideration must, of course, be primarily metallurgical.

It has always seemed to me that the most profitable approach to the consideration of blast-furnace operation is to regard it as a concentration process. The purer the ultimate product, the less work will be required in the operation of steel-making.

Now the blast-furnace is not particularly amenable to changes in practice and the number of ways in which the steel-makers' problems can be eased through control of blast-furnace operation is distinctly limited.

The steel-maker asks three things from the blast-furnace operator :—

i. A regular supply in quantities appropriate to the size of his plant units and the rate of his operation.

ii. An iron of suitable composition for his process.

iii. Uniformity of product from day to day and, indeed, from cast to cast.

The first of these requisites is determined, or should have been, when the plant was planned in the first place. If mixers or mixer type ladles are included in the general scheme there is less need for great rigidity in this direction. The number of steel-making units which follow each blast-furnace varies very largely from case to case, but no matter how well the production of the blast-furnace and the iron consumption of the steel-making units may be balanced, a modern plant can hardly be expected to operate efficiently without storage accommodation in the form of a mixer or mixers. This is particularly true of converter units, but it applies also to the open hearth. In this connection, of course, I am speaking here merely of quantities and not of quality and iron variations at which we must look later. It is germane to this aspect of the matter to look for a few moments, in a little more detail, at the question of blast-furnace size. The arguments in favour of the largest practicable unit in any individual case are, at first sight, formidable. It is claimed that capital charges, conversion costs and, under the correct conditions, uniformity of product all appear to favour the large furnace. Closer examination, however, shows that some of these claims are ephemeral. The uniformity of product and, indeed, the smooth working of the furnace itself, can only be achieved with the highest degree of burden preparation, both as regards ore and coke ; without this the large furnace becomes unmanageable. From a capital cost point of view the difference in capital charges per ton as between the moderate and the large-size furnace is eliminated. , Figures also show that for hearth diameters between 23ft and 27ft there is no capital advantage in the increased size.

Size and Flexibility

So far as actual production cost is concerned the difference in cost of iron between, say, a 20ft and a 25ft furnace is indeed a very small percentage of the total iron cost. On the technical side upsets in production, which can occur, even with the most elaborate preliminary treatment of the burden, can cause serious difficulties in the steel works, whilst relining periods, especially in times of high demand, can cause real problems in the continuity of steel production, particularly where iron is a high proportion of the total charge. It has yet to be established, certainly in this country, on local material, that the very large unit offers advantages which counterbalance its inherent weaknesses. The argument for the large furnace is primarily economic or, perhaps in line with current notions, one of productivity. If we remember that an appreciable proportion of the capital cost on the larger furnace is attributable to ore preparation and similar ancillary operations, it will be appreciated that the selection of furnace size, even on a financial basis, is not as simple as would appear at first sight. To my mind, the relative flexibility to be attained with smaller blast-furnaces is something well worth paying for. Finally, on purely technical grounds, whilst it may be attractive to use a very large unit on particular types of burden, we in this country, especially with our own supplies of raw material—both ore and coke—may well find that an increase in hearth size can be bought only at the expense of reduced reaction times with all that that means in the way of irregular furnace operation.

On the question of the composition of the iron to be sent forward to the steel works, there is, in fact, not very much which the blast-furnace operator can do inside the limits of each particular case. The blast furnace operation may certainly be a concentration, but it is not a purification process. I suppose an iron specification from the steel-maker to the blast-furnace operator would be on the general lines " as little of everything, except iron, as possible." As we all know, the phosphorus is determined by the type of stock available and, for any one operation, should be reasonably constant, whilst the carbon is something which the steel-maker must accept in any case. This brings us to the old question of how far the blast-furnace can achieve the steel-maker's requirements as regards silicon and sulphur. The relationship between silicon and sulphur arising in blast-furnace operation is, of course, one of the fundamental difficulties which will always be with us, but there is a further limitation in this connection which is not so often recognised. There are many blast-furnace burdens in which the alumina is so high that it is virtually impossible to secure an ideally low silicon in the iron, even if sulphur were taken care of as it can be and is nowadays in other directions. Many producers on the Continent employing the Bessemer process are indeed fortunate in that

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they can, because of the comparatively low alumina in their slags, secure an iron into the mixers with 0·3 per cent silicon or less. With the home ores in this country and with many of the ores being imported from abroad the alumina in the slags reaches a point where this cannot be achieved. The dividing line between the desirable and the undesirable here would appear to be about 18·5 per cent alumina in the slag. When this alumina reaches something of the order of 22 per cent to 23 per cent the range in which slag fluidity is attainable is very narrow and, in addition, it is almost impossible to secure a silicon content below approximately 0·6 per cent.

Ore Preparation

The third requirement mentioned, "uniformity of composition from cast to cast," is perhaps the most difficult of attainment. With all the steps which have been taken and with all the improvements which have been adopted, it has to be admitted that, especially in the matter of silicon and sulphur, the day-to-day composition of the irons from any one blast-furnace leaves much to be desired. The biggest step forward which has been taken in recent years is undoubtedly in the realm of ore preparation. Uniformity of burden size, including coke, most certainly improves the regularity of product, and a steadier rate of driving can be maintained when this precaution is taken. The day cannot be very far distant when all blast-furnace materials will be pre-treated, if only mechanically, for reasons of uniformity in composition alone. As I have already indicated to you, preliminary ore treatment is an essential on large furnaces, but it is also extremely necessary, in some degree, on blast-furnaces of any size, especially where the stock is irregular, either in mechanical size or composition. This means, in effect, that in most cases crushing and screening plants are only the first step in the right direction. They should be accompanied, wherever conditions permit, with adequate mixing plants. The gain in steadiness of operation may represent very large increases in output when troubles, due to furnace irregularities, are ironed out, as they can be with such equipment.

It should not be overlooked either that crushing equipment, apart from producing a burden of uniform size, can be employed to assist in the purely metallurgical side of furnace operation. An example of this might be of interest. For many years trouble was experienced on furnaces employing Northamptonshire ore, where the burden content had too large a percentage of unweathered carbonates high in ferrous iron. By adjusting crushing plant conditions to give a smaller size of piece the "hanging" and "late reduction" which were experienced with the normal burden were almost completely eliminated. The improvement in output and smoothness of working by this simple expedient was quite remarkable.

These remarks on blast-furnace operation may seem merely a restatement of the obvious, but a full appreciation of the matters indicated is essential for the successful production of iron of uniform quality for any type of steel-making process. It may not be possible to secure the actual composition which the steel-maker would wish, but it is possible, using all modern devices, to improve the standard of consistency from cast to cast and from day to day.

One further point must be made which is of national rather than general application. The raw materials available to the industry in this country for blast-furnace operation are not, in the forseeable future, likely to produce easy times, for either the blast-furnace operator or the steel-maker. Neither the home ores nor the imported ores, so far as one can see, are likely to produce conditions which will give, automatically, smooth running, low-cost practice. So far as the blast-furnace operator is concerned, one may feel confident that these difficulties can be surmounted and, within the limitations which we have already noted, that the iron available to the steel-maker will improve, at least in consistency and regularity of quality.

With this conclusion as a basis we may now turn to the steel-making processes. Depending on the ores available, there are three broad groups of iron to be expected from the blast-furnaces :—

(1) Iron with a maximum of 0·5 per cent phosphorus.

(2) Iron with over 1·5 per cent phosphorus,

(3) Iron with 0·5 per cent to 1·5 per cent phosphorus.

It is this classification which should, in theory at least, determine the type of steel-making practice employed. There is no question that the first group is pre-eminently a basic open-hearth iron, irrespective of the iron/scrap ratio of the steel charge, and that the operation of that process in fixed furnaces presents no problems.

The second group would be regarded, on the Continent, as a basic Bessemer iron, and, as we know, such irons are generally converted by that process. In this country, however, considerable quantities of steel are produced from irons of this type by the use of large tilting furnaces in which the phosphorus can be removed by using adequate slag volumes which are taken off from time to time as the condition of the bath demands. These two methods, in regular use, by which high-phosphorus irons can be handled, and something of the limitations of both, together with their potential economics, are worthy of fuller consideration.

Basic Bessemer Development

The last few years have seen such rapid development in the evolution of the basic Bessemer process that it is perhaps worth while stressing the fact that, for many purposes hitherto regarded as outside its orbit, this process should have serious consideration as an alternative steel-making method to the basic open-hearth and, particularly, to the large tilting furnace operation. It may seem strange that one should have to stress this fact in what was the home of the process in this country, but it does not seem to be generally realised that it is now possible with no more control than is normally applied to open-hearth operation to secure results from the basic Bessemer process which are equal in all respects, so far as quality is concerned, to those obtainable by the open hearth. The production of low-nitrogen, deep-drawing steels and materials of similar grades in large tonnages is now established practice. It is worth recording that the average nitrogen content of the steels produced by one of the new Bessemer variations is about half of that found in ordinary commercial open-hearth material.

It cannot now even be argued that the basic Bessemer process cannot assimilate scrap, as, with the temperature control attainable with oxygen enrichment, this difficulty can be overcome, at least to the point of internal uprising scrap in any ordinary steel works. Any limitations on the use of this process cannot now, in fact, be based on technical grounds.

Before dealing in a general way with relative costs it would be perhaps desirable to mention the outstanding technical differences between the two processes as distinct from their product. Whilst both can claim to give a regular flow of steel to the mills, the Bessemer unit gives this normally in smaller quantities, although a very high production rate per hour can be maintained with a properly balanced plant. In this connection it should be noted that the capital cost per ton of ingot can be, under suitable conditions, very much lower for Bessemer than for open-hearth plant. In general, a higher slag credit is obtainable from the Bessemer process. The most serious limitation of the Bessemer process is that, for the finishing of higher carbon steels, it presents problems which do not arise in the case of the open hearth. This is particularly true of killed steels.

It is sometimes argued that, because of relatively low yields compared with large tilting furnace practice, the Bessemer process is seriously handicapped. This disadvantage is not as weighty as is sometimes supposed. As very few large tilting furnaces are operated on 100 per cent iron—indeed, it is claimed that they operate best using 20 per cent to 30 per cent scrap—it is a little difficult to make direct comparisons. The somewhat illogical difference in cost in this country between pig iron and scrap appears, at first sight, very strongly to favour the open-hearth process. In addition to this a high yield is achieved through the reduction of the oxides used in refining. As this increment of iron is obtained from ore or scale and must obviously cost less than iron, as in the Bessemer processes, coming from the blast-furnace, the material cost in the Bessemer per ton of product is inevitably higher at the same iron cost. On the other hand, the conversion cost is substantially lower.

Relative Costs

A comparison in economics, therefore, can conveniently be based on the differences between the ferrous material and the conversion cost. The Bessemer process cost for fluxes and fettling is almost four times that of the open hearth, but, against this, the open hearth is substantially higher in fuel, maintenance and mixer costs. The Bessemer process has also a considerable advantage in slag credits. Most other conversion items (wages, &c.) are similar. Taking all these variations into account, it can be shown that there is a difference in conversion costs to-day, ignoring capital charges, of at least 30s. per ton in favour of the Bessemer method. It is against this 30s. per ton that one must consider the differences in material cost, arising from the yield in the two processes. If we assume that the Bessemer yield is 90 per cent and the open-hearth yield 100 per cent, the two processes should break even in ingot cost at an iron cost of £15 per ton. In so far as scrap is employed in the Bessemer process (additions up to 20 per cent are now quite practicable with oxygen enrichment), the iron cost could thus be higher and still give equality in ingot cost. With the newer oxygen enrichment practices, too, oxides can be used in the converter, thus bringing the yields into line with the open hearth. These figures are, of course, approximations, but what I do wish to stress is that the saving on conversion in the Bessemer process can cover, under suitable conditions, the difference in yields in favour of the open hearth. Below a certain iron cost, therefore, the Bessemer process gives a cheaper product than the open hearth, but a very careful assessment is required of material available and practice employed before a final decision could be arrived at in favour of the one or the other process on economic grounds.

So far as this country is concerned, the third group of irons mentioned (phosphorus 0·5 per cent to 1·5 per cent) is probably,

especially in the future, of greatest importance, not only from the point of view of total tonnage, but also because of the metallurgical problems which it presents. It is in this range that metallurgists are groping for the correct answer, as regards conversion, and it is, to my mind, the most formidable problem with which our industry has to deal. There is a growing body of evidence which suggests that the best integrated plants in this country can hope for, which are not based directly on home ores, will be about 0·7 per cent phosphorus in the iron. Where scrap supplies can be used as a diluent, good and economic open hearth fixed furnace operation is practicable. As much of the iron available, however, is likely to come into the upper part of the range with an average of 1·25 per cent phosphorus, the major problem remains. It seems probable that, at and above this figure, the most useful and economic method would be to raise the phosphorus in the iron by additions to the blast-furnace and use the Bessemer process for conversion. The alternative, of course, where other conditions made it desirable, is to use the large tilting furnace without increasing the phosphorus. There seems to be no doubt as to where the balance of inclination lies. Metallurgists in this country to-day appear to concentrate their thought and discussion on the pre-refining, in some shape or another, of the irons in this indeterminate group with a view to rendering them suitable for straight fixed open-hearth furnace practice.

Pre-Refining—Objects

The pre-refining of pig iron prior to steel-making by ladle, mixer or, in more elaborate form, by duplexing practices, certainly looks attractive, if approached from the angle of easing the load on the open-hearth furnace itself, but in very few cases do the proposals and practices examined to date stand up to the cold winds of economics.

The general aim of all these treatments is to remove the major portion of the silicon, achieve some improvement in sulphur content and reduce ultimate refining times by a reduction in carbon, whilst the phosphorus is brought to limits compatible with fast-working, fixed open-hearth practice ; in fact, to a point where low slag volumes are possible. Where does the balance of advantage lie between the many contending proposals which have been advanced as answers to this problem ?

You will know that the removal of these various elements in greater or lesser amounts presents varying degrees of difficulty. The advent of the relatively cheap oxygen obtained from the tonnage plants now being built extensively helps, at least in some degree, to deal with part of the problem. The removal of silicon to any desired limit is undoubtedly more economic than to attempt the production of low-silicon iron direct from the blast-furnaces. With cheap oxygen available a simple treatment is now being carried out in the ladles at one or two plants on the Continent. This operation is possibly of even greater interest to us in this country. I mentioned earlier the reasons for the extreme difficulty in obtaining low-silicon irons direct from the blast-furnace, and, with these if anything on the increase, the desiliconisation of the iron by oxygen blowing in the ladle is at least a considerable easement of a difficult situation.

The removal of sulphur or rather the reduction of sulphur to permissible limits, limits which vary from industry to industry, is an entirely different problem. It has, over the past twenty years, received a great deal of attention, and I think it would be a correct summing up of the position to say that, so long as the ultimate sulphur in the finished steel need not be less than 0·04 per cent, little or no difficulty need be experienced in sulphur control. There is, however, a growing demand, understandable in the light of modern knowledge of the effect of sulphur on the behaviour of the material, for steel with sulphur below 0·02 per cent. It has been possible, over many years, by the soda ash treatment, to reduce sulphur in iron from the blast-furnace as high as 0·25 per cent to under 0·04 per cent into the steel furnaces, but this does not meet the new problem of extremely low sulphur. The well-known difficulty of the ultimate elimination of residues appears in acute form. The question is continuously under study by research teams in this and other countries.

The removal of carbon and phosphorus is really a major metallurgical operation, involving higher temperatures than that of the molten iron and the formation of suitable slags. It is, in fact, only practicable in something more elaborate than the ladle treatments which may be and, indeed, are permissible in the case of silicon and sulphur. In practice, as most of you know, the partial removal of carbon and phosphorus can only be achieved by a furnace operation of some kind, i.e. mixer or converter. The pre-refining of iron in mixers has been and is frequently employed, not only for the removal of silicon, phosphorus and some carbon, but, a more dubious practice, for the assimilation of some of the scrap which would normally be melted in the basic open-hearth furnace.

Pre-Refining—Methods

An inherent difficulty in combined mixer/open-hearth furnace operation, when practised on any major scale, is the balancing of units. My own experience has been that, although the open-hearth operating times are shortened considerably, it is difficult to plan operations for regularity of working with more than two open-hearth furnaces depending on one mixer or pre-refining furnace. While the removal of silicon could be achieved in this way without serious difficulties in timing, the removal of phosphorus and carbon by normal oxidation methods, making and using a suitable slag, is another matter. We are, in fact, removing the time-consuming operation from the open hearth without speeding it up to any appreciable extent. The logical results of this is that, to achieve a satisfactory balance between the pre-refining vessel and the open hearth, the size of the former assumes formidable proportions. It is self-evident too that, in a mixer of any size, the depth of the bath itself relative to its surface area is a serious handicap : this, particularly, as the oxidation reactions are dependent, to a very large extent, on the effective activity of a slag. It is hard to see that, for any given quantity of steel, a saving of three to four hours in the melting furnace rate, which is merely transferred to another larger furnace, is a justifiable operation. I am well aware that mixer refining practice is extensively employed, but, as soon as its objective goes beyond silicon removal, I find it difficult to accept the usefulness of the system.

It is interesting to look at this combination of operations, however, from another angle. Mixer refining may be the best way of maintaining the relatively low temperatures requisite for rapid phosphorus removal. When this permits of the finishing furnace being maintained continuously at higher operating temperatures, some metallurgical advantage has indeed been gained. It is difficult to resist the conclusion, however, that if pre-refining is desirable or necessary, so far as the phosphorus and carbon are concerned, the converter is a better tool than the large mixer. It has at least three appreciable advantages : (*a*) direct oxidation in the bath ; (*b*) a lower fuel cost ; and (*c*) rapid working with easier time control within the open hearth time schedule. With the advent of cheap tonnage oxygen, these advantages are increased. It is accepted, of course, that, if a converter is used for the intermediate stage, a mixer, even if only an inactive one as a storage vessel, is an essential component of the plant. The argument for the mixer operation is that it is there in any case ; that for the converter that it is a more efficient and suitable tool for the job.

It is certainly curious, the whole aim of pre-refining being to achieve time saving in the final furnace operation at the open hearth, that so little attention is being given to speeding up the pre-refining period itself. Methods are being accepted which do not in fact offer any prospect of faster conversion over the whole operation from the liquid iron to the molten steel in the ladle.

The basic idea underlying pre-refining is time saving : the reduction of expensive hours from start to finish of a conversion operation. Unless, therefore, the whole process is completed at a lower total furnace cost per ton than is possible by orthodox methods the adoption of an intermediate refining process is not justifiable. It seems to me that our open hearth operators have been bewitched by the notion of four heats per day per open hearth. If this is to be achieved by merely giving the furnace little or no work to do, it is evident that the intermediate phosphorus iron group is not a suitable material on which to start. The metallurgical load has to be carried somewhere : if not on the steel furnace, where ?

Intriguing possibilities arise from a metallurgical standpoint when one considers the alternatives of oxide hearths or slag washing. It may well be that a manageable furnace with an iron oxide hearth will one day be built which will be a practical commercial proposition. Theoretically, this is the ideal way to reduce phosphorus. I do not see any great hope, however, for slag washing processes. In practice, the method is difficult and messy. It is almost impossible to devise means of producing the fine shower of metal into the molten slag which will give the necessary speed of reaction, and metallic losses will inevitably be higher.

Duplexing

Reverting to more normal types of plant, I said a moment ago that the converter was a better unit for pre-refining than the mixer. Its use in this connection brings us to a consideration of duplexing. It is true, in duplexing, something more is attempted than mere pre-refining. It is frequently used to achieve the highest production possible from any given open-hearth plant. In times of high demand the use of acid converters for the first stage is indeed regular practice for the removal of high silicon and most of the carbon in the iron, especially where the exigencies of blast-furnace practice result in irons of undesirable compositions. This is the particular form in which it is practised in the U.S.A. In this country and on the Continent its application to higher phosphorus irons, using basic converters for the first stage, has also been employed. So far as outputs are concerned, the nominal capacity of any open-hearth plant can be greatly increased by its use. It must be pointed out, however, that the increase in output is not as

great as if the same iron had been finished directly in the converter.

In view of the new flexibility of the basic Bessemer process, as regards quality of product, it is doubtful if, in planning a new plant, even with a high iron/scrap ratio, one would be justified in adopting duplexing as the basis of the entire operation. Experience shows that a blown metal can be delivered to the open hearth for finishing at about 30s. per ton less than the cost of basic Bessemer ingot made from the same iron, but I doubt if anyone here would be prepared to operate an open-hearth furnace and make finished steel for 30s. per ton of product, even with blown metal as the starting point. In other words, the duplex ingot will inevitably be higher in cost than the Bessemer ingot made directly from the same iron. There are cases, notably in electric furnace finishing practice, where the savings achieved in power and electrode cost make the system attractive, although these disappear when low-cost suitable scrap is available. Another instance of the balance between material and conversion cost which has so much relevance in all the production problems of our industry.

On the general subject of outputs attainable by duplexing, some figures based on actual experience may be of interest. Table I gives in summary form the results obtained on a series of campaigns varying the charge on furnaces normally working on scrap/cold pig iron basis. The blown metal used, except where otherwise stated, contained 0·1 per cent to 0·2 per cent phosphorus, but was otherwise practically pure iron. The increase in hourly output and the saving in fuel are clearly shown.

TABLE I.—*Comparison of Duplexing Practices: Basic Converter—Fixed Open-hearth Furnace*

No.	Charge in tons			Good ingot, per hour	Therms, per ton
	Blown metal	Scrap	Cold iron (0·3/0·4% P.)		
A... ...	—	98	42	10·2	57
B... ...	49	49	42	13·4	44
C... ...	73	25	42	16·1	38
D... ...	100	—	42	21·4	35
E... ...	75 50*	—	—	26·3	34

*50 partially blown. Per cent
Carbon ... ... 1·5
Phosphorus ... ... 1·75

In 20-ton electric furnaces blown metal of a similar nature was substituted for good cold scrap, and the results, average figures on campaigns of considerable length, are shown in Table II.

TABLE II

Charge	Tons/hour	kWh/ingot ton
Cold scrap	3·6	740
Blown metal	4·7	420

The furnaces are employed on a special product, requiring special casting pit arrangements, and no doubt higher figures could be obtained in normal steel-making. These figures will serve to show the order of gain in output which may be obtained if one is prepared to accept the extra cost of blown metal.

You will have gathered from all this that if high outputs are desired from relatively high-phosphorus iron, a converter plant is a nice handy unit to have in any shop, especially when periodic spells of very high production are likely to be encountered.

A study of production cost in almost any conceivable combination of two-stage processes, however, shows that, unless the two stages can be carried out in one furnace unit, the final ingot cost will be higher than with the more orthodox methods of operation, even with iron involving high metallurgical loads. The savings achieved by reducing the final open-hearth or, for that matter, electric furnace finishing times, are not great enough to pay for the additional operating cost incurred in using two furnaces. A possible exception to this generalisation might be the use of all-iron charges for the open-hearth furnace for carbon steels which could not be made for plant or quality reasons by the Bessemer process. Where scrap quantities are available—over about 25 per cent of the charge weight—it is of general application. This may seem a startling, even a defeatist, conclusion, when one thinks of the increases in production per hour which are attainable using pure materials in the open hearth.

An Alternative

There is, however, another solution to the problem of intermediate phosphorus irons, which, to my mind, has possibly not received the attention which it merits. One is entitled to ask whether we are, in fact, right in assuming that, in any one plant unit, the steel-making practice should be of a standardised nature. Where blast-furnaces and steel works are depending on a mixed variety of ores, with varying phosphorus contents, it is possible that the tonnage of each type available could be segregated in order to produce two distinct kinds of iron, each suitable for a different method of steel-making. There seems to be a tendency, not only in any individual works, but nationally, to accept average figures in planning. If these averages tend to produce irons of the intermediate group it will be agreed that production difficulties are being increased. The possibilities of improved flexibility of operation by facing up to an operating programme of this kind are well worth serious consideration under conditions prevailing in this country on all but home ore plants. It is realised, of course, that there are practical difficulties in operating two practices in any one melting shop, but the ultimate gain on economics would probably be well worth while, at least as a temporary measure until some more efficient way of dealing with pig iron containing 0·5 per cent to 1·5 per cent phosphorus is evolved.

You may feel that these remarks and conclusions are in the nature of limitations to existing processes and practices. It is only by recognising frankly that no further progress can be made in any particular direction beyond a certain point that we can hope to strike out in new directions and make ultimate progress in the development of our industry.

I would not have you think that anything I have said or any conclusions at which I have arrived are intended as a direct criticism of what has been done, what is being done and what is projected in any specific district. One cannot detail a national plan on national averages.

Availability of raw materials and their nature and properties inevitably affect the general picture and real planning can only be carried out given a firm foundation on which to build. An acceptance or, at least, a critical examination of the principles which we have been discussing is, in the light of any given circumstances, a vital pre-requisite to the establishment of a successful industrial practice.

Floor Malting at Grimsby

A new malting, having an annual output of 40,000 quarters, has recently been brought into production by Sandars and Co., Ltd., at Grimsby. It is of conventional design and the reinforced concrete building has been laid out to carry out the processes necessary to produce floor-made malt. Mechanical handling has been adopted so that the barley is untouched by hand throughout the process.

THE new malting, which was recently built at Grimsby for Sandars and Co., Ltd., is now in production, and replaces an older building, destroyed during the war. Reinforced concrete construction was adopted for the building which has been designed to produce various grades of malt by the age-old method of floor malting rather than by the more modern system of pneumatic malting. It was considered by the company that floor malting was the more natural way of preparing malt since it is possible by this method to follow closely the germinating process and to control it. There are, of course, economic disadvantages in floor malting in that larger buildings are required and also a larger labour force, but the new malting, by reason of its design, specialised equipment, mechanical handling arrangements and attention to flow can be operated by a comparatively small amount of labour. The malting follows the lines of conventional design and consists broadly of a barley intake, drying and storage plant, steeping cisterns, germinating floors, kilns, malt storage and despatch. The barley intake is at the north end of the building and the movement of the grain while being processed is from the north end to the outloading section at the south end.

Broadly speaking, the building is divided into east and west sections by a central corridor and many components are duplicated and are interconnected, so that the process can be maintained in the event of a breakdown occurring in any particular unit. The barley silos, of which there are forty-two, have a total capacity of between 18,000 to 21,000 quarters and the battery of ninety-six malt silos can hold about 14,400 quarters, while the annual overall production of the installation is up to 50,000 quarters of barley as malt.

The building is 375ft in length by 124ft in breadth and is generally 50ft in height except in way of the two main elevator towers. Some 800 Franki piles up to 30ft long support the malting, which has a ground floor area of 46,500 square feet, a reinforced concrete frame and floors, and was constructed by the Trussed Concrete Steel Company, Ltd. The outer walls are of double brick, there being an air space of 1½in in way of the silo section and a 9in air space plus a single wall of insulation brick in way of the growing floors. These floors have an area of about 57,500 sq. ft. and are covered with "Betonac" a non-absorbent dustless, acid-resistant paving, while the windows are double glazed with non-actinic glass. Beneath the lower growing floor is a space to insulate from the ground and this is air conditioned so that all the floors operate under the same conditions. The concrete silos have finely rubbed interiors and the kilns, also of concrete, have external "limpet" asbestos insulation, while the internal surface is treated with acid-resistant paint.

The architects for the building were Messrs. Evans, Clark and Woollatt.

Barley Section

At the intake end, shown in our photograph, the barley is delivered in sacks by lorry, each sack containing about 16 stones, and unloaded on to a concrete plinth at the level of the lorry floor. The sacks can be emptied direct into two steel hoppers, each of 10 quarters capacity, or can be stood up inside the building for inspection and then fed into internal intake hoppers. From the hoppers two bucket elevators, each driven by 4 h.p. electrical motors, raise the grain through a height of 64ft at the rate of 100 quarters per hour so that the average time to unload a 3-ton lorry is about ten minutes. The grain passes through an Avery automatic bulk weighing machine, usually set to weigh in units of 16 stones, then a roughing machine, where the

Intake End of Malting

sticks and straw are removed. After that the weighed-in barley can be moved to the silos through the dressing machine and a half-corn separator ; or to the five silos reserved for undried barley ; or, with or without screening, direct to the steeps ; or to the four reservoir hoppers which are located over corresponding barley sweating drums.

The barley is moved from point to point on individual floors by means of an interlocking series of screw conveyors which are sited to run from east to west and from north to south and which operate in conjunction with associated elevators. In fact, the plant is extremely flexible and barley can be conveyed from any of the four silos to any of the process plants and, indeed, should the temperature of the barley rise in any particular silo the grain can be removed, recirculated and returned to the same silo. The five solos allocated to store undried barley are each provided with an air ventilation system in which air is delivered by fans to perforated pipes, in the bottom of the silo cone, so that the barley can be aerated. With this system it is possible to store barley, having a 17 per cent moisture content, for periods of between two to three months; however, it is essential to ensure that the relative humidity of the atmosphere is lower than that of the barley when using the aeration plant and indicators are fitted for this purpose.

All the silos are of concrete and measure approximately 12ft 6in square by 32ft deep and hold up to 500 quarters each. In the cones of the dried barley silos there are ventilating ports which are covered with wedge wire and which provide not only a certain degree of natural ventilation but will allow an induced draught system to be installed. A careful watch is maintained over the temperature of the barley and to facilitate this an electrical temperature indicating system is fitted so as to give readings at three points in the depth of each silo, namely, at 8ft, 16ft and 24ft. An indicating panel is mounted in the office of the intake section in which is also a rack holding glass jars containing samples of the grain in each silo, the quantity in each jar serving to indicate the level of the grain in that particular silo. Another important part of the installation is the equipment installed to remove dust from all points in the intake and silo section where the grain becomes loose in transit. Mechanisation increases the dust problem and the dust extraction plant supplied by Thermotank, Ltd., collects the dust and delivers it to closed compartments in the basement, where it is sacked ready for disposal.

The barley in the four reservoir hoppers, each of which is of 250 quarters capacity, is fed into four batch pattern sweating drums each holding 50 quarters and each capable of dealing with two or three or even four batches per day, depending upon the amount of moisture to be removed. One of our photographs shows the sweating drums which are located at ground floor level and are about 15ft long by 8ft 6in diameter. An average moisture reduction of 6 per cent is achieved by the circulation of hot air which enters an end chamber in the drum, passes along six semi-circular ducts, on the shell of the drum, and is drawn through the barley to a tube, lying in the axis of the drum, by an exhaust fan. It is possible to discharge and refill a drum in approximately 15 minutes, and while the grain is being discharged the exhaust fan is left running to act as an additional safeguard against escape of dust into the building.

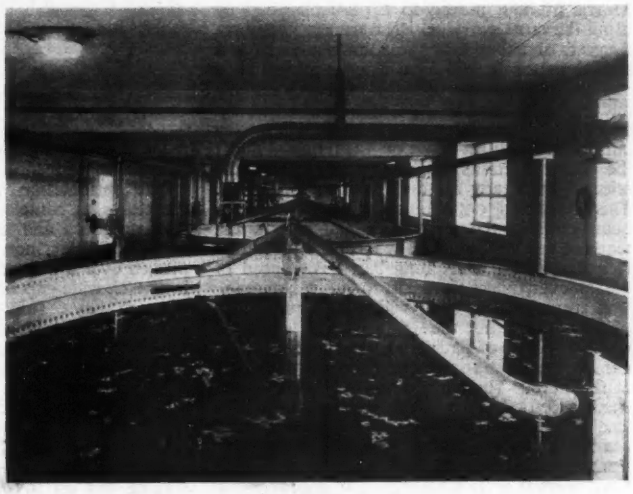
In the basement is a battery of four oil-fired furnaces manufactured by Hubbards Combustion, Ltd., and they heat the air which, mixed with the products of combustion, enters the drum at 145 deg. Fah. and when its exit temperature is about 92 deg. Fah. then the moisture content of the grain is approximately 12 per cent. The exhaust air passes through a dust settlement chamber before entering the atmosphere. The furnaces, which burn light distillate fuel, each have automatically controlled firing equipment complete with safety devices and recording instruments.

Under each sweating drum is a hopper of sufficient capacity to hold the total contents of the drum and from the hoppers worm conveyors and elevators transfer the dried grain at a rate of 100 quarters per hour per section to the screens or silos. Screening of the grain is carried out on two flat-bed reciprocating screens which remove the screenings and small barley while allowing the head sample of barley to pass on to a pair of indented cylinders for the removal of half corns, after which the barley is transferred by elevators and overhead worm conveyors to the silos or fed to cross conveyors for loading out to supply other maltings. The screenings, small barley and broken barley are trunked to a lower floor to be bagged.

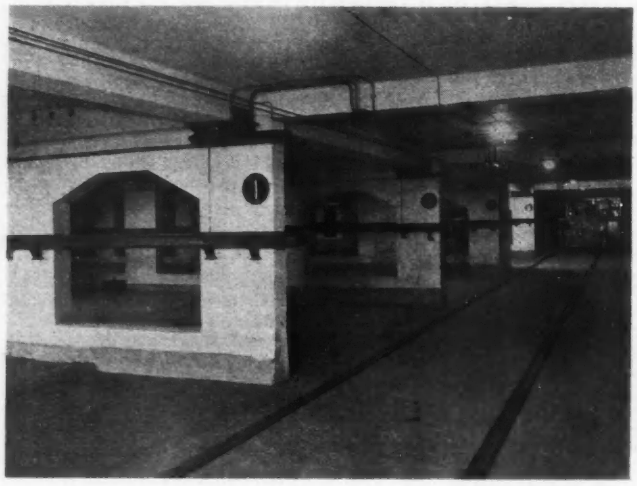
Malting Floor Section

From the silos the barley passes on to the steeping section by means of worm conveyors installed in the underbin room beneath the silos, and two elevators which raise the grain some 96ft after which the grain is automatically weighed before being fed into two reservoir hoppers each of 75 quarters capacity. These are placed over two inner steeps, of which there are six arranged across the building in two groups, and can be seen in our illustration. The barley is fed into the inner steep and water is added. After one day in the inner steep the barley and water are pumped into the outer steep and then, after a further twenty-four hours, they are pumped into the middle steep of the group of

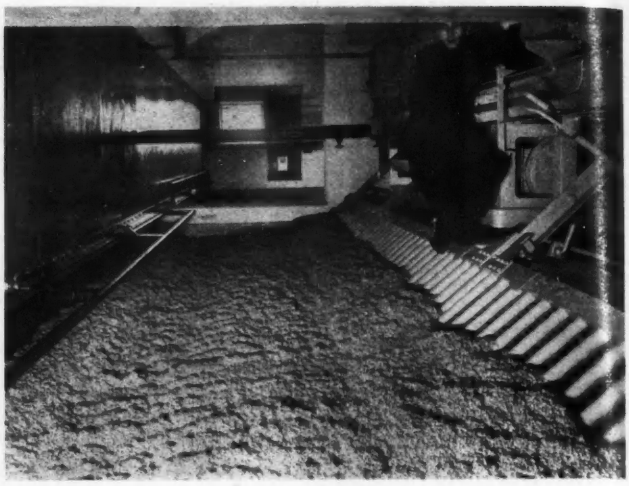
Barley Sweating Drums



Barley Steeps



Germinating Bays and Cross Corridor



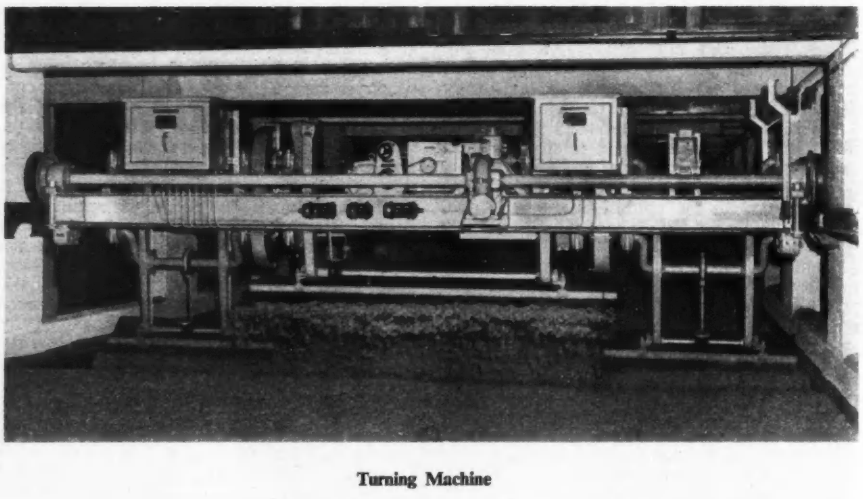
Loading Green Malt to Kiln

three. As arranged the steeping is on a nominal three day basis and two batches of barley can be wetted per day when in full production. All six steeps are 15ft in diameter and of steel conical pattern and the inner and outer steeps of each group have discharge valves suitable for passing barley and water together, while the middle steep discharges steeped barley only. At the base of each steep there are connections for the water supply and for water drainage and also for the supply of air to pipe coils for aeration purposes. A pair of electrically driven centrifugal pumps, one of which is a standby, serve the steeps and 75 quarters of steeping barley can be transferred from steep to steep. Cleaning of the vessel is carried out by high pressure sprays in about thirty minutes. The operation thoroughly washes and scours the grain without damage and provides additional aeration to that given by the pipe coils in the steep cones; there are also rotating sparge arms, air pressure gauges and thermometers to check the water temperature. Water for the operation is provided from one of the company's own wells, which is capable of a flow of 15,000 gallons per hour for twenty-four hours, without lowering the water level in the well, at a temperature which remains constant within 2 deg. of 50 deg. Fah. throughout the year. The water is drawn into a pressure tank which delivers at the rate of 26,000 gallons per hour to the steeps.

There are four germinating floors, one of which we illustrate, each divided into six bays, about 18ft wide by 120ft in length, across the ends of which is a cross corridor about 10ft 6in wide at each level and these floors are linked by means of a lift. Serving the working floors are three turning machines and two tank cars, all of which are transferred, in electrically driven transporters, from floor to floor by the 7-ton Morris lift and moved to a particular bay by using the cross corridor. The transporters have a speed of about 60ft per minute and have a special motor for giving a slow approach to a bay and for entering the lift. Grain from the middle steep is fed through steel portable spouts, which connect floor to floor, to the tank car already in place on the required floor; the car is transported afterwards to the selected bay ready for the spreading operation. This is carried out continuously until the 75 quarters from the steep is spread out to the required depth, about 6in, by means of a rotating feed device and a levelling bar. The speed of the tank car ranges from 35ft to 70ft per minute.

A special machine, of which we reproduce a photograph, turns the grain and is equipped with three sets of flat spring steel turning tines, namely, one centre set and two narrower sets at the sides. The travel drive is powered by a small electric motor while another motor of small horsepower serves to operate the connecting rods, linking the cranks of the tine frames which are oscillated by an eccentric from the lower crankshaft. The speed of the machine can be varied between 2ft and 60ft per minute and the turning forks between 40 and 60 r.p.m. All the floor machines run on steel rails set at the requisite height above the floor while the transporter runs on a rail track set in the floor. A 35kW motor-driven generator supplies current at 110V d.c. to a series of overhead bare copper conductors from which it is collected by the machines.

The malting floors are air conditioned and to cut down heat leakage cavity walls are used; to avoid forming obstructions the extraction ducting is inset in the outer walls which present a flush surface, while the supply ducts are sited between the centre stanchions in the central walking gangway. The ducting is of suitably prepared Rangoon teak. Considerations of ground space dictated the position of the air conditioning plant which is installed on the roof and consists of ammonia machines, supplied by J. and E. Hall, Ltd., in association with an atmospheric condenser.



Turning Machine

The germination process, which begins in the steeps, is completed on the air conditioned malting floors and after a specific number of days the barley, now known as green malt, is pushed over a weir at the south end of the floor into a 2ft wide gap which runs for the full width of each bay. This bulldozing operation, as seen in one of our photographs, is carried out by a row of closely spaced rods which are attached to the spreading machines and which can be hinged down to touch the floor. The grain drops into a two-way Redler conveyor running across the building at ground floor level and the speed of discharge from the floors is governed by the capacity of the conveyor. To prevent the grain spilling out on to the lower floors there is a steel screen extending from floor to ceiling, at each of the three lower floors, with the bottom section of each screen consisting of a balanced and hinged discharge door.

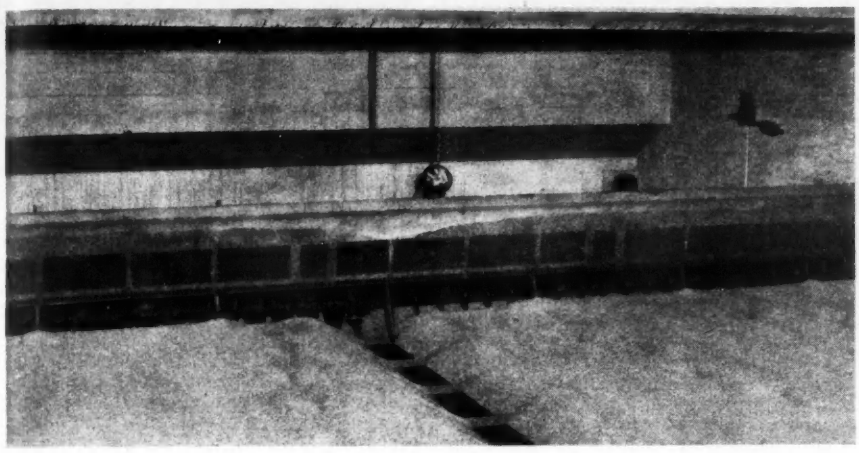
The Redler conveyor carries the grain to two kiln feeding elevators which raise the green malt at the rate of 100 quarters per hour each, to two Redler conveyors at the top of the building, which in turn pass the grain to conveyor units leading to the kiln turrets. From the turret the grain is fed by gravity to the kiln floor by means of a rotating and movable spout which is used to spread the grain evenly over the kiln floor. Thus, by mechanical means 75 quarters of green malt can be transferred from two malting bays to the kiln in approximately 1½ hours. Between the working floor section and the kilns a bay about 9ft wide is interposed, complete with access stairways, and it serves to insulate the working floors from the kiln section and raise the efficiency of the air conditioning plant.

Malt Section

There are four kilns in the width of the building, and they each have a floor measuring 24ft 9in in width by 46ft in length, sufficient to take 75 quarters of grain with a loading depth of about 16in. Each kiln roof is built in the shape of two pyramids, each having an ample outlet turret fitted with a fan capable of extracting more than 9000 cubic feet of air per minute. The wedge wire floor is supported on steelwork while below the floor is a concrete plenum chamber which is connected with the furnace stacks, of which there are two, there being two furnaces to each kiln. Over each furnace is a hot air disperser, arranged inside the plenum chamber and the height of the furnace stack has been designed, in conjunction

with the furnace, to allow natural draught to be used as an alternative to forced draught.

The furnaces burn light distillate oil and are automatically controlled through the regulation of fuel and air supplies by means of a motorised valve, mounted on the furnace front, operated by a main relay. This is actuated by another relay which is operated by contacts in a temperature recorder, if the temperature in the mixing chamber should vary more than a certain amount above or below the instrument setting. The temperature of the air leaving the kiln is also recorded to measure the heat going out and there are also remote controls for adjusting the vanes, fixed below each extractor fan, to regulate the volume of air required.



Kiln Stripper

In the kilns the natural growth of the barley, which reached a certain stage on the malting floors, is killed by the passage of the hot air combined with the products of combustion from the oil-fired furnaces. During this time the grain is turned by a special machine fitted with "T" shaped paddles which oscillate through a small arc. The kiln turner runs on rails and is moved over the floor by a slotted shaft and dog clutch arrangement while mechanical stops are provided for reversing. After a predetermined period the kilning is complete and the malt is ready for discharge; this is done by a spiral conveyor stripper, which we illustrate, and which runs on the same rails as the kiln turner but has an independent drive. The stripper moves forward at about 2ft per minute and pushes the grain into a centre trough which is uncovered by swinging downwards a line of hinged doors by the manual operation of a wheel placed outside the kiln. A spiral worm conveyor in the trough discharges the grain into a cooling hopper, the discharge operation being completed in one hour after which the kiln is immediately reloaded to minimise heat losses.

From the cooling hopper, under each kiln, the malt in culm is released into a pair of transverse Redler conveyors leading to two 100-quarters-per-hour elevators, which raise the malt to the top of the building, where it is fed by gravity to malt screens, of rotary barrel pattern, approximately 36in diameter by 12ft in length. Here the malt is buffed, polished and the rootlets or malt culms are removed and bagged on a lower floor. The finished head sample passes to the boot of a pair of elevators for lifting to a bulk weighing machine before being delivered by a system of Redler conveyors and portable chutes to a battery of malt silos, numbering ninety-six, built of reinforced concrete.

The silos are arranged on either side of the central corridor and each measures about 6ft 9in square by 35ft deep and holds approximately 150 quarters, which is equal to two kiln loads. Air-tight manhole covers similar to those at the barley silos are fitted and, at the outlet cones to each silo, there is a rack and pinion outlet door.

Portable chutes mounted in a wheeled frame draw off the malt to two conveyors of 100 quarters per hour capacity, in the underbin room, leading to two main elevators in which it is raised to the top of the despatch department. Here the malt either by-passes or passes over a flat bed screen 3ft 6in in width by 9ft long to an automatic weighing machine. When the malt is to be outloaded in bulk it passes through an Avery automatic bulk weighing machine and then by chain conveyor to chutes which discharge direct in a bulk railway van at 100 quarters per hour. For delivery by sack the malt is delivered to two worm conveyors from which outlet ports feed into a sacking-up weigher. There is adequate standing-up space for the 12 stone sacks of malt and circular holes in the floor allow the sacks to be dropped on to a rotatable balanced discharge chute, on the ground floor, which delivers to a stand arranged at a height suitable for manhandling to lorries. Dust extraction plant is installed (as in the barley section) at all points where dust is likely to be present.

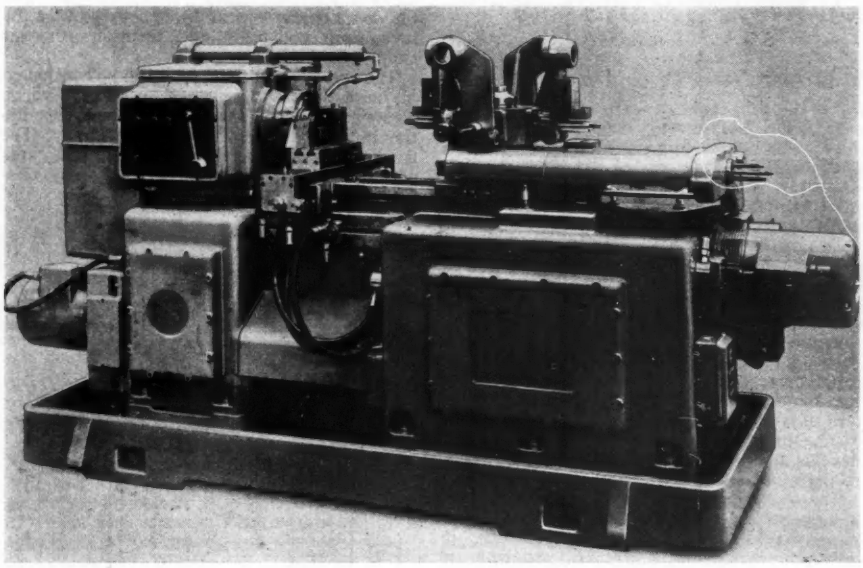
Oil for the furnaces is stored in two tanks, mounted on a site adjacent to the malting; each holds 7500 gallons. In an adjoining building the 6600V public electricity supply is transformed to 415V and 240V by one 750kVA and two 500kVA transformers, the switchgear being supplied by Switchgear and Cowans, Ltd., while the English Electric Company, Ltd., has provided the switchgear for the low tension station. All the electrical work has been the responsibility of the Alliance Electrical Company, Ltd., London, while Robert Boby, Ltd., Bury St. Edmunds, was the main contractor for the mechanical equipment.

Chucking Automatic

THE illustration below shows the first of a batch of chucking automatics which have been designed and are being built by Murad Developments, Ltd., Stocklake, Aylesbury, Bucks, for the Fabrique Nationale D'Armes de Guerre, of Liege, Belgium. In this machine all the slides are actuated hydraulically under the control of solenoid-operated valves. Its dead-length collet is also operated hydraulically through a lever which is interlocked to prevent the machine being started unless the collet is loaded and closed. The machine has a centre height of 7½in, and in this particular instance the spindle has been designed to admit a component 2 3/16in diameter. Provision is made so that the spindle can be run with the slides out of action; alternatively the slides can be put into operation with the spindle at rest.

Independent front and rear cross slide units can be mounted at different positions along the bed, and each slide has independent controls for quick approach, feed, quick return, and stop. The rate of feed is controlled by setting a dial at the rear of the machine and within the range infinitely variable rates of feed are available. The turret slide is equipped with a four-position turret, the rate of feed for each turret position being independently controlled by setting separate dials. Quick approach, feed, quick return motions are provided for each turret face, and the point of change over from quick approach to feed is adjustable by sliding dogs. The maximum traverse of the turret slide is 15in.

The machine cycle can be controlled for one, two or four positions of the turret and the spindle speed can be arranged to change at any position of the turret. The machine is fully automatic and when the operator has loaded and closed the collet he presses the start button and the machine then carries out all the working operations and stops at the end of the cycle.



Chucking Automatic for Belgium

MR. A. MCARTHUR MORISON.—It is with regret that we record the death of Mr. A. McArthur Morison, which occurred in Glasgow. Mr. Morison, who was sixty-eight years of age, was a ship surveyor and engineer, a founder member of the Society of Consulting Marine Engineers and Ship Surveyors, and a member of the Institution of Naval Architects and of the Institute of Marine Engineers.

Pressurised Electrical System for Hazardous Atmospheres

A PRESSURISED electrical system for use in hazardous atmospheres has been developed by The General Electric Company, Ltd. It makes use of the principle that explosion hazards may be avoided by enclosing the electrical wiring and apparatus under pressure in an envelope of non-flammable gas, such as CO_2. This principle was used many years ago in the Dusterloh system in Germany and, later, by H. O. Dixon at West Horton Collieries. In both these systems any break in the containing tube or envelope resulted in a fall in internal pressure which operated a pressure valve near the main switch and that in turn isolated the faulty section from the supply. A disadvantage of both systems was the time that elapsed during the draining of the air before the switch would operate.

The method described and illustrated here is designed to eliminate this drawback. The operation of the new system depends on a sensitive pressure-responsive switch (Figs. 1 and 2), which is a micro-switch, kept closed by

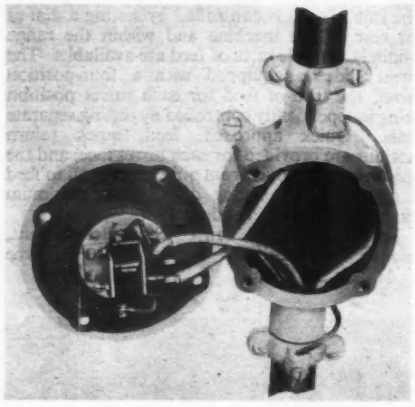


Fig. 1—Pressure Responsive Switch

positive gas pressure within the system, acting against a spring bias. Upon failure of this pressure the spring opens the switch contacts and thus isolates the faulty circuit. To protect a complete system it is divided into convenient pressurised sections and each section is fitted with pressure-responsive switches; these switches are connected in series and supplied from a transformer, through a relay (Fig. 3). Pressure failure at any point causes the nearest pressure switch to open, breaking the supply to the control relay and thus tripping the circuit breaker and isolating the faulty circuit. Protection is therefore given against a fracture in a casting or cover glass of a lamp, a break in a flexible tube or conduit, a leakage in a switch, relay or fuse cover, or a failure of the air supply.

The transformer relay and switch are housed in a pressurised control box (Fig. 4) installed in a convenient position—in a danger area, if required. While the control box can be in a hazardous area the circuit breaker must be of flameproof construction suitable for operating in the area concerned, and situated in a Group II or III position, or must be installed in a safe area. The circuit breaker must be one specially adapted to break the circuit and cut off the current in the pressurised area immediately the air supply fails. This can be done by a simple pressure-responsive switch situated alongside the breaker, if convenient, which breaks the circuit of the no-volt coil in its associated circuit breaker. This breaker (Fig. 3) is so designed that it can be reset only by the operation of a special removable key, held by a responsible person, and then only if the pressure-responsive switch is closed by the air supply.

To ensure that the system will operate under any atmospheric conditions without the danger of condensation small needle valves are placed at convenient points in the pressure system to allow for drainage and, if required, a slight permanent bleed. In Fig. 5 we illustrate a special barrier coupling box for connecting the pneumatic and power supply from one section

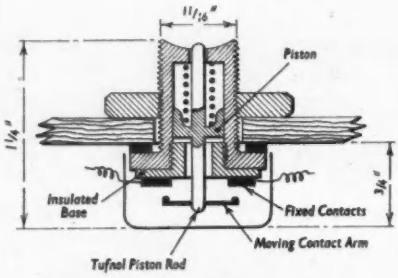


Fig. 2—Diagram of Pressure Switch

to another in a safe area; the supply is then taken from the barrier box into the hazardous area in which the equipment is pressurised.

One of the fittings made by The General Electric Company, Ltd., for use with the pressurised system is a portable lamp made of "Neoprene," an insulating material which is resistant to the action of oil and petrol and can therefore be used, for example, in service stations or aircraft hangers. In this particular form of equipment the pressure-responsive switch is an integral part of the body of the lamp.

A special fitting has also been designed for a 2ft fluorescent lighting tube in a "Perspex" cover. For use with these fittings a "Neoprene" hose is available; it contains separate channels for the air supply and the lighting and pilot wires, and the construction is stiff enough to prevent the tube from collapsing and throttling the air supply.

The operation of the system can be considered in more detail by referring to Fig. 3, which shows a diagram of a section of a recent installation in the hydrogen area of an oil refinery. The flameproof circuit breaker is installed in an area which can be either Group II or III and is con-

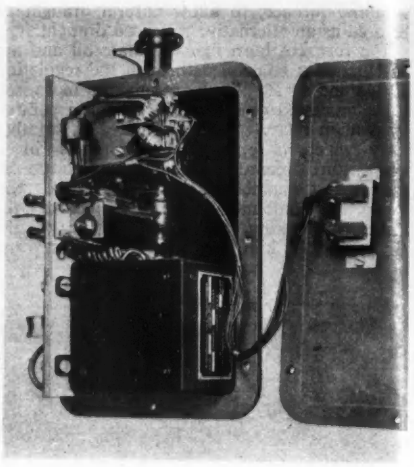
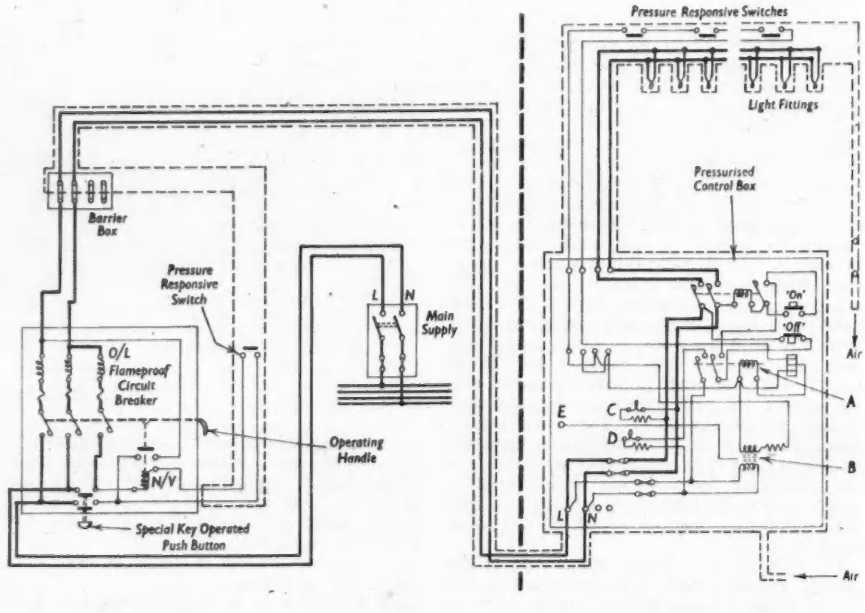


Fig. 4—Control Box

trolled primarily by a no-volt coil which is in series with a pressure-responsive switch. Therefore the circuit breaker cannot be closed unless the no-volt coil is energised, that is, unless the air supply is satisfactory and the pressure switch is closed. Conversely, failure of the air supply causes the pressure switch to open, de-energising the no-volt coil and opening the circuit breaker contacts.

The control cabinet is installed in the hydrogen area. When the air pressure is at the required value of 3½ lb per square inch the pressure-responsive switches are all closed, the relay *A* is energised through the transformer *B* and the air pressure indicator lamp *D* is alive. At the same time the closure of the relay contacts *A* allows the main contactor to close when the "On" push button is depressed. Then the main lighting circuit is complete through the control box and the circuit breaker to the supply mains. If the air pressure falls the pressure switches operate and break the supply circuit of the relay *A*, the contacts of which open and thereby de-energise the main contactor coil.

Details of the air control arrangements are omitted from the diagram. A typical installation would probably include, on the air inlet side, a filter, reducing valve and pressure gauge, a stop



A—Intrinsically safe relay.
B—Intrinsically safe transformer.
C—Supply indicator lamp.
D—Air pressure indicator lamp.
E—Internal earth terminal

Section of system under pressure indicated by dotted lines.

Fig. 3—Diagram of Pressurised Electrical Installation

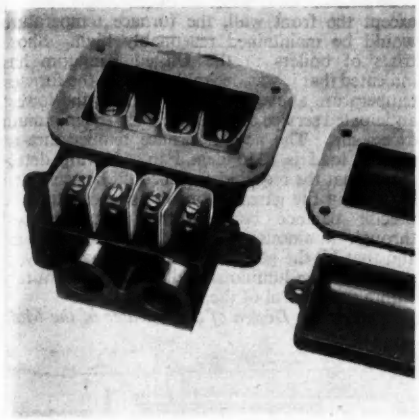


Fig. 4—Barrier Coupling Box

valve, a safety valve, and a needle valve. On the outlet side there would be a scavenging valve and, if required, a constant bleed valve.

We learn that a possible development of the pressurised system now under consideration is the provision of a combined flameproof compartment to house the control gear and the main automatic switch. This equipment would, however, be installed either in a safe area or in a Group II or III area. Provision would be made in the hydrogen area whereby the outside control could be switched off manually, if required, by a switch on the intrinsically safe circuit. This facility would not prejudice the automatic control in the event of air supply failure.

Synthesis of Two Marine Water-Tube Boilers*

By Commander (E.) L. BAKER, D.S.C., R.N. Ret.†

In this paper a brief résumé is given of the important lessons learnt from the operation of oil-fired water-tube boilers at sea since 1925. *These are linked with the shipowners' requirements—particularly those pertaining to the post-war merchant service—and the development of two designs of boiler from these requirements is shown. In this way it is possible to accept fundamentally different designs of boiler for application in the same ship.*

Introduction

The majority of marine water-tube boilers prior to 1939 were in service in one or other of the world's navies, the few in the mercantile marine being installed in the larger passenger liners. In the navies, a number of problems had arisen of which the following are the main :—

(1) Circulation defects.
(2) External (gas side) corrosion of heating surfaces.
(3) Internal (water side) corrosion of heating surfaces.
(4) Superheater tube leakage.
(5) Cracking of drums between tube holes.

During and immediately after the 1939–45 war, the influence of the American-built "Liberty," "Victory" and "C-3" ships was felt increasingly, and cargo shipowners began to fit "D," two-furnace and header types of boiler. The experience with American economisers was initially satisfactory, but troubles were experienced which can be classified into three groups.

First, where external soot deposits caused losses in heat transfer, choking of the gas passages and soot fires with consequent bursting of the tube due to lack of adequate water flow. Secondly, these economisers were fitted with complicated "clean-out" fittings which gave trouble relatively early. Thirdly, trouble has been experienced with the expanded joints, and it has proved virtually impossible to make tight a joint once it has leaked unless the tube has been replaced.

In connection with the defects listed above, it is now usual to provide an adequate margin of area of unheated downcomers, to ensure safety of circulation at outputs considerably in excess of the design figures. Tube failures due to faulty circulation are therefore virtually unknown in post-war ships.

External corrosion was caused largely by soot collections becoming damp during the idle periods of the plant. To overcome this difficulty it is now usual to "streamline" the heating surface so that natural soot traps are eliminated as far as is practicable. Internal corrosion has been eliminated, so far as the Blue Funnel fleet is concerned, by the adoption of the "Alfloc" water treatment.

Leakage of superheater tubes occurred mainly at the expanded joint. In Admiralty three-drum boilers this was due to creep, caused by uneven steam and gas distribution. The former was caused by an inadequate pressure loss across the surface in relation to the losses in the headers, and the latter was due to inadequate design of the pre-war combustion equipment. In modern practice the pressure loss has been increased, and low superheat steam is now obtained by desuperheating instead of taking saturated steam direct from the drum.

Cracking both in the tube sheets and end plates of drums was primarily caused by stress corrosion. It has therefore been eliminated by removal of the stress raisers, namely, small knuckle radii in the ends and excessive arboring in the tube sheet.

To meet mercantile marine conditions simplicity of operation is most desirable plus maximum efficiency, so that fuel bills may be kept low.

So far as boilers are concerned, probably the most important component has had the least attention, namely, the combustion equipment. The typical curves in Fig. 1 show that for a constant output of steam the efficiency depends upon the actual percentage of excess air. Some excess air leaks in through casings, but anything in excess of 15 per cent can be attributed to inefficient combustion in the furnace. The author has seen 8·5 per cent carbon dioxide or 85 per cent excess air logged and has obtained with similar equipment 10·5 per cent carbon dioxide or 52 per cent excess air, and with a change of equipment 13 per cent carbon dioxide or 23 per cent excess air.

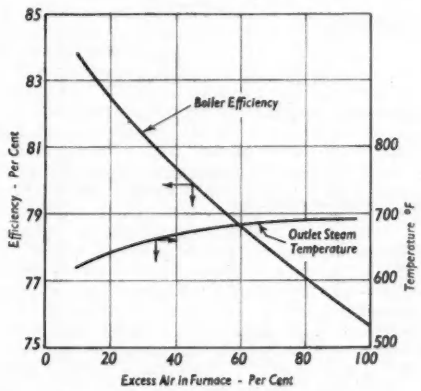
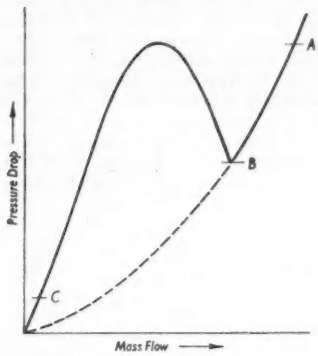


Fig. 1—Boiler Efficiency and Outlet Steam Temperature

Effect of Pressure Losses

Two losses are of particular significance to the designer, first, that through the economiser, and, secondly, that through the superheater. The "cycle" designer wishes both to be kept to the lowest possible limits, while the boiler designer wishes them to be adequate to ensure a safe margin for maloperation. The risk associated with too low a loss through the economiser is that it may be operating in that part of the flow curve where three flow rates are possible at the same heat input, corresponding to heated water, or one of two water-steam mixtures (Fig. 2). With most practical economisers the number of paths in parallel must align itself with the requirements of the total surface needed and of the inlet and outlet headers. A pressure loss of 30 lb to 40 lb per square inch is usually adequate in marine designs. The risk with superheaters is complicated by a desire to provide a margin of output above that required by a normal operation. Specification of a large margin means that the allowable pressure loss in the superheater will be absorbed at the overload condition, with, consequently, less at the normal maximum output, and increased risk of damage to superheater tubes. In a two-boiler ship with one boiler out of operation about 75 per cent of the normal full speed is adequate for the safety of the ship.



A—Flow in excess of this point is stable.
B—Steam generation begins.
C—Superheating begins.

Fig. 2—Variation of Pressure Drop with Mass Flow

Design Detail

The requirements specified for the boilers of the S.S. "Nestor" were :

	Main	Auxiliary
Normal output, pounds per hour	25,000	3,600
Maximum output, pounds per hour	30,000	
Feed inlet temperature, deg. Fah.	240–230	80
Efficiency, per cent	88·5 at overload	74
Pressure at outlet, pounds per square inch...	625	100
Steam temperature at outlet, deg. Fah. ...	950–750	Dry and saturated

Consideration of the basis plans (Fig. 3) and the above data indicates differences of a fundamental character, and it may be of value to determine the reasons for these differences within the same ship.

Circulation.—Probably the most significant difference is the mode of circulation in the boiler ; the main boiler has natural circulation, whilst the auxiliary boiler has forced circulation of the La Mont type. The author's reason for selecting natural circulation for the main boilers was that in his company the experience with water-tube boilers was relatively small, and he did not feel justified in risking a break in the steadily increasing confidence of the officers in the fleet.

In the case of the auxiliary boiler, however, there were three major reasons for introducing the forced-circulation principle. First, the auxiliary boiler was not required to ensure the safety of the ship. Secondly, considerable weight could be saved by substituting a water-tube boiler for the previously conventional fire-tube boiler and a more compact boiler could be made with forced circulation than with natural circulation. Thirdly, in both the steam and motorships there was a considerable source of waste heat in the exhaust of the diesel generators. By using waste heat boilers it was possible to design for sufficient steam to be generated to supply the normal domestic needs of the ship, unless palm oil was being carried ; at the same time, by suitable connections, they could be used as economisers when the maximum duty of the boiler was required.

Efficiency.—The experience in the Blue Funnel fleet with water-tube boilers complete with economisers and air heaters has been entirely satisfactory with funnel gas temperatures as low as 260 deg. Fah. In view of the direct influence on the fuel consumption of the boiler efficiency at sea, it was decided to achieve

* Paper read before Institution of Mechanical Engineers on November 13th. Abstract.

† Chief Superintendent Engineer, Blue Funnel Line.

88·5 per cent efficiency at the designed maximum operating condition, equivalent to a funnel gas temperature of 270 deg. Fah. Under abnormal operating conditions the air heater can be by-passed on the gas and air sides, so that unduly low gas temperatures are not experienced and trouble due to condensation of acid vapour is avoided.

The auxiliary boiler is required for two duties, first, to provide a small quantity of steam for the domestic needs of the ship (not exceeding 500 lb per hour), and, secondly, to provide about 3600 lb per hour for heating vegetable oils, carried in deep tanks, and oil fuel, in the double bottoms, under conditions of extreme cold. The latter duties are of rare occurrence, and a low efficiency at full output can be accepted to ensure that the peak efficiency is not passed at the more usual low output.

Combustion Equipment.—The main boilers are provided with oil fuel registers fitted with open-shut air controls and two-position burners, whereas the auxiliary boiler is provided with fully automatic burners. Pressure atomisation is used in both, but control on the auxiliary boiler is by spill. The combustion air is supplied by forced and induced draught for the main boilers and by forced draught for the auxiliary boiler.

The basic reason for these choices is that the complement provides a fireman to tend the two main boilers whilst at sea and two firemen whilst manœuvring into and out of port. No donkeyman is carried to tend the auxiliary boiler in port.

The combustion equipment for the main boilers is simple and to put a burner into service involves only opening the air supply to the burner, pushing the burner forward into the operating position, increasing the fan speeds (if necessary) and turning on the oil, no adjustments being made once the preliminary settings have been fixed.

The auxiliary boiler is different; variation below each maximum duty of 500 lb or 3600 lb per hour is dependent upon factors beyond the control of the engineer. The output of the boiler varies, therefore, and yet it has no real watchkeeper. Pressure changes can be very fast with a La Mont boiler, and automatic adjustment of the burner output to meet steam demand was fitted, using a spill type of burner for the appropriate range. Ignition is automatic as it had been found that young engineers found difficulty in avoiding occasional flashbacks, and safeguards were fitted to ensure that the boiler was protected in case of low water and flame failure.

Integration of the Generator, Superheater and Economiser Surface.—It proved possible to divorce the superheater from the generator surface; the design of the furnace and the design of the superheater therefore could each be considered on its own separate merits (Fig. 4). The designers of the combustion equipment considered that the fuel could be burnt within a furnace 6ft long. A spare burner was required to enable full power to be obtained whilst cleaning an atomiser. A total of four boiler burners were therefore needed, with a maximum fuel output duty of 720 lb per hour per burner.

The combustion equipment had to achieve the duty with boiler fuels varying in viscosity from 40 to 6500 seconds Redwood No. 1 at 100 deg. Fah., although the range at present experienced on the service lies between 40 and 3500. The furnace was required to be as compact as possible, so that with all walls water cooled except the front wall, the furnace temperature would be maintained reasonably high. Shore trials of boilers in the United Kingdom has indicated that it was desirable to keep the furnace temperature above 2400 deg. Fah. at the lowest anticipated service output, to ensure the minimum excess air. The actual furnace temperature at normal load is 2315 deg. Fah. Having determined that the required steam could be generated by cooling the gases before the superheater, the precise balance between the heat absorbed through luminous radiation from the furnace and that by the generator tubes through convection and non-luminous radiation, was entirely within the control of the designers.

Logic of the Design of Superheater of the Main Boiler.—As these boilers were intended for use at 625 lb per square inch, 950 deg. Fah., it was essential to provide a temperature control to limit steam temperature automatically to a maximum of 950 deg. Fah. to ensure that creep phenomena could not adversely affect the safe operative life. To provide as much safety as possible, the high temperature end of the superheater should also be arranged so that unbalanced gas or steam flow could not occur. As a result of experiences with slagged superheaters, it was specified that the superheaters could be washed with fresh water with minimum interference and the least risk of damage to the furnace refractory.

Satisfactory experiences with superheaters of the MeLeSco type in Admiralty boilers decided the use of the Concen tube joint for up to a maximum temperature of 850 deg. Fah., the top limit for this type of fitting. The design produced by the Superheater Company was the neatest for this section of the superheater, as

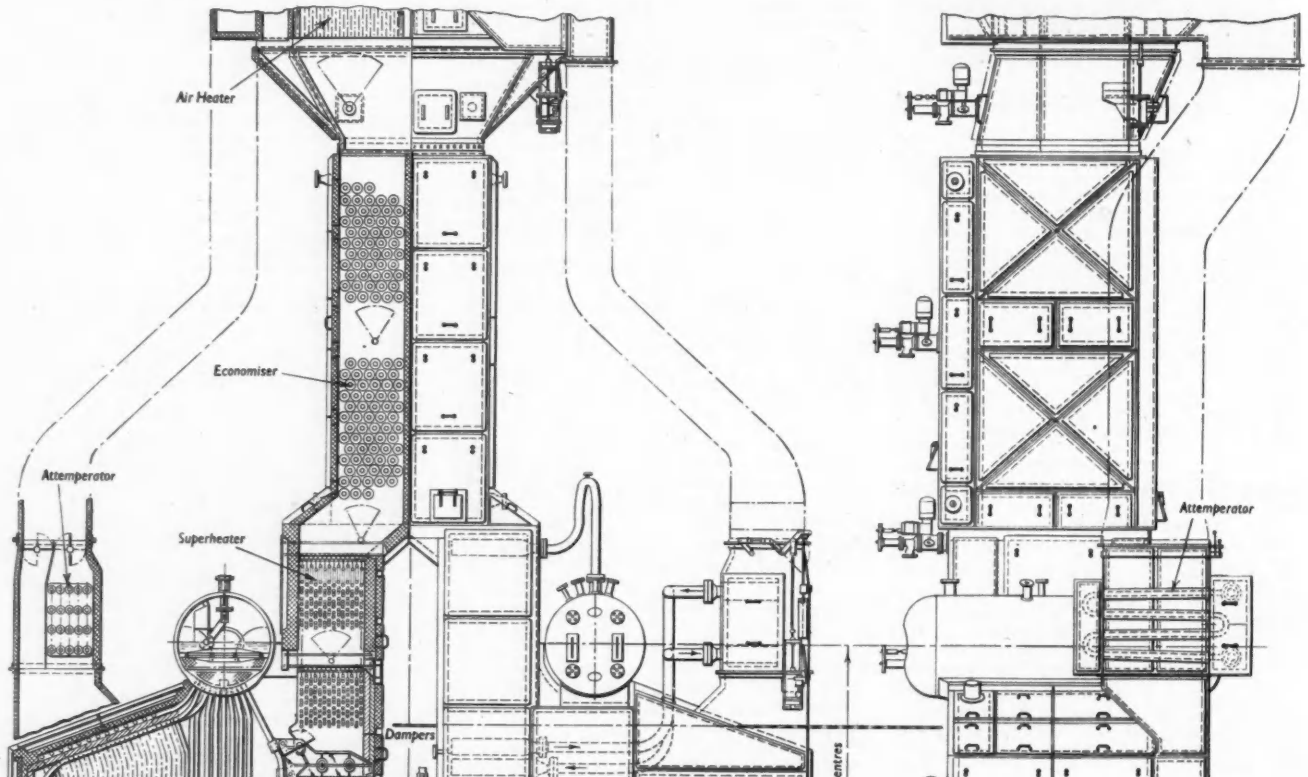
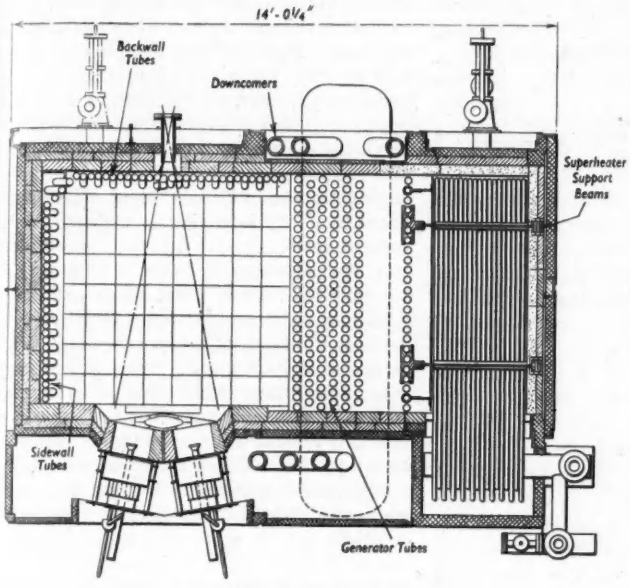


Fig. 3—General Arrangement of Single-Furnace Controlled-Superheat Boilers

intermediate headers were eliminated between the first two sections.

The turbine manufacturers required the steam to the astern turbines not to exceed 750 deg. Fah. at the maximum boiler output, so that the superheater was to provide for means of control over a narrow range of temperatures at 950 deg. Fah., and of reducing the temperature to 750 deg. Fah., and it had to be physically remote from the furnace. To prevent overheating by malopera-



Showing arrangement for furnace tubes, combustion equipment, generator and downcomer tubes and superheater support beams.

Fig. 4—Sectional Plan of Single-Furnace Controlled-Superheat Boiler

tion, it was considered essential to have all the fuel fired into one furnace. With one furnace, a new method of superheater control had to be devised and, by integrating this requirement with the physical separation of the superheater and the furnace, it was concluded that damper control provided the best solution.

This decision resulted in a reduction in weight, and the separation of the two components allowed the superheater to be designed as a heat exchanger without regard for the geometrical limitations imposed by other sections of the boiler. The requirement for good steam distribution meant a long steam path and relatively few paths in parallel, which also suited the geometry of the space limitations in the ship. The long steam path resulted in a welded design, with the length of elements kept within reasonable proportions for handling by separation into three sections. The maximum temperature under the astern conditions did not exceed 800 deg. Fah. at the outlet of the second section, so that the first two sections were of the MeLeSco design. The final section of the superheater was of all-welded design, to eliminate possible tube end leakage due to fluctuations in temperature. The header and tube material was 1 per cent chromium–0·6 per cent molybdenum steel which could be easily welded.

The superheater being in three sections enabled a convenient arrangement of gas dampers to be made, so that the surface of the superheater was greatly reduced for astern operation. The high-temperature section of the superheater was out of the gas path when there was greatest risk of the boiler being mishandled during a rapid manœuvre. It was simple to arrange for the attemperator to be fitted conveniently into the steam and air circuits.

The attemperator is constructed of finned tube and is damper controlled. Under normal operating conditions, preheated air is used as the cooling medium, and the damper is operated automatically to adjust the final steam temperature as near as practicable to 950 deg. When a low final temperature is required the by-pass on the air heater is opened and the damper is put in the full-open position, so that cold air is used to reduce the temperature of the steam from the second section of the superheater. The small amount of heating done in the final section, which is now by-passed, raises the temperature to a maximum of 750 deg. Fah. These damper operations can be controlled by a single lever on the engine manœuvring platform, so that the control of steam temperature essential for the operation of the turbines is under the control of the turbine operator.

In a high-efficiency boiler with a high superheat and a low feed inlet temperature, the proportion of heat actually required for steam generation is small, relative to more conventional designs. Much of the required heat is absorbed by the water-cooled furnace, and by shifting a greater amount of heat absorption to the economiser it was possible to reduce to seven the rows of tubes required for steam generation. These could be located before the superheater, which was freed from artificial space limitations.

The economiser is of all-welded construction to eliminate the risks associated with expanded tube joints. It is required to deal with a high gas temperature owing to the omission of generator surface after the superheater. The feed water is heated from 245 deg. to 400 deg. Fah. whilst the gas temperature is reduced from 840 deg. to 400 deg. Fah. The remaining reduction of the gas temperature to 270 deg. Fah. is carried out in an air heater with 2in tubes arranged for three passes on the air side. By-passes are fitted to both gas and air sides for all conditions below the full rated output.

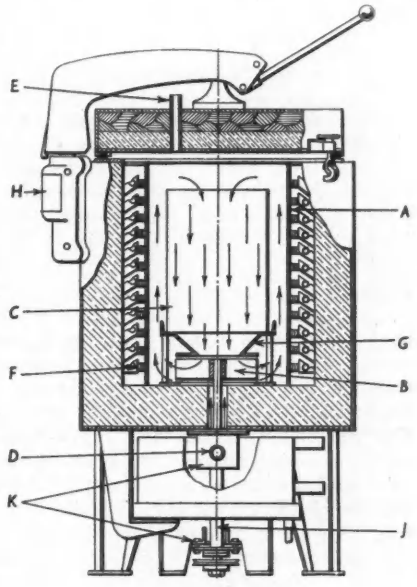
Miscellaneous Points of Interest.—Points of interest external to the boiler are : first, provision was made for keeping the main boilers heated in port by circulation. It was anticipated that in port there would be surplus steam from the waste heat boilers, and it was decided to circulate boiler water through a steam heater and back through the economiser. In this way, it is possible to keep the machinery at very short notice for steam without waste of fuel. Secondly, in view of the difficulty in preventing feathering of the safety valves subsequent to their having lifted whilst manœuvring in or out of port, the steam system was designed for an otherwise unnecessarily high pressure, and an electrically assisted safety valve of small release capacity was fitted intended only to " take the top off " the boiler. Thirdly, the boiler is fitted with devices intended to give some additional measure of protection against the serious ill-effects of solid or liquid carry over into and beyond the superheater.

One device consists of an insulated probe, which is charged with a small alternating voltage. In the event of the water or foam rising to an undesirable level, a small current passes from one electrode to earth and thereby actuates a micro-switch. The second device consists of a steam sampling fitting, which passes steam through a condenser to a conductivity cell. The conductivity of the condensate varies with the amount of solids contained therein ; by selecting the maximum allowable conductivity, the equivalent limiting current can be made to operate a second micro-switch. The two micro-switches are used in the first two ships to operate warning lights, but, if experience is satisfactory at sea with these new units, it is intended to use the available power to operate selected safety devices. For example, the micro-switch in connection with the probes might be used to trip the steam shut-off to the turbines and the feed supply to the boiler, so that damage to the superheaters, steam pipes and turbines would not ensue from a failure of the automatic water level control. Similarly, the second switch might reduce the quantity of oil fired to the boiler by operating a restricting orifice, so that carry-over could be reduced by reducing the steaming rate of the boiler without, however, putting the boiler off the line. This action could be less drastic, because the risk of damage is less immediate than in the former case.

Steam Tempering Furnace

THE use of steam for tempering and hardening processes has been the subject of recent study by the Research Organisation of Wild-Barfield Electric Furnaces, Ltd., Watford, Herts. This work indicates that the use of steam leads to an improvement in the life of tools and that the resulting blue oxide surface finish is resistant to corrosion and of pleasing appearance. The process can be carried out during the normal tempering or as an additional treatment and the need for pickling is eliminated.

As a result of this work the company has developed a furnace specially designed for steam tempering. In its general conception the new furnace is evolved from the Wild-Barfield vertical forced-air-circulation furnaces. A section through the furnace is shown in the accompanying schematic diagram. It will be seen that the furnace chamber contains a retort *A* for sealing off the effective working space, so that close



Steam Tempering Furnace

control of atmospheric working conditions can be achieved. Steam is supplied to the retort through an entry *D* in the gland box below the chamber. Positive circulation of the steam inside the retort is produced by a centrifugal fan *B*, as indicated by the arrows. To reduce working costs the size of the retort is made a minimum, consistent with the dimensions of the work basket *C*. A steam outlet *E* is provided through the door, which is sealed and provided with four clamps and a door switch *H* and is opened by lifting and swinging aside.

Heating is provided by nickel-chromium coiled wire elements *F* mounted on insulating supports between the wall and the retort. A throat *G* in the base of the chamber helps to direct the flow of steam and forms a platform supporting the work basket. The fan is driven by an outrigger motor through a heat-resisting shaft *J* carried in outrigger bearings.

Four standard sizes of furnace are available, and they are fitted with work baskets ranging from 13in diameter by 19in deep to 28in diameter by 38in deep. In the smaller sizes no pit is required for carrying out maintenance, but it is recommended that the larger sizes should be sunk in a pit so that the furnace top may be at a convenient working height.

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"LONDON PARTICULARS"

More and more it has become widely appreciated that just under twelve months ago a disaster of the first magnitude occurred in London. It is not possible to calculate exactly how many deaths were caused by the "smog" or "London Particular" that blacked out the centre of London from December 5th to December 8th last year. But, as compared with the death-rate per week at the same dates in 1951, the figures rose alarmingly during the "smog" period and remained high for several weeks thereafter; and there was a significant correlation between the rise in the numbers of deaths and the recorded concentrations of smoke and sulphur dioxide in the atmosphere. At least 4000 people lost their lives (very probably the true figure was at least twice that number) as a direct consequence of experiencing the "smog." Similar conditions have certainly been experienced in London before and they have also been experienced elsewhere in the world. But this latest example of a "smog" was notable for the fact that more scientific measurements were made than ever before, though the number was far fewer than research workers would desire for a really thorough investigation. They revealed that smoke concentrations during the five days of fog rose to a long-sustained maximum of 4·46 milligrammes per cubic metre at London County Hall and sulphur dioxide concentrations to a similarly sustained concentration at the same locality of 1·34 parts per million. These figures should be compared with the mean figures for December, 1951, of 0·43 milligramme per cubic metre and 0·22 part per million for smoke and SO_2 respectively. Those concentrations during the "smog" were certainly lethal to some of the population, as the death figures prove. Yet—it illustrates the fact that there is still much to learn—the sulphur dioxide concentration never approached the minimum value of 10 parts per million, hitherto generally accepted as toxic for an exposure of several hours. Furthermore, there is some evidence to indicate a correlation between deaths and those much lighter smoke and SO_2 concentrations which occur under conditions that do not approach the danger of those of "smog."

It is beyond question that the chief offender in producing "smog" is the domestic grate. For it has been estimated that about half of the total smoke pollution in this country comes from domestic dwellings. But engineers and industrialists cannot shake off responsibility merely by suggesting that the more widespread use of smokeless fuels domestically would greatly mitigate "smog" conditions. For factory furnaces undoubtedly contribute their quota of smoke and gases, and so do power-house chimneys. Moreover, it is to the engineer that the public appeals to suggest remedies just as it is to the Fuel Research Station that the Government turns for the scientific investigation of atmospheric pollution. Nor are engineers unwilling to help. For to them the emission of smoke from chimneys is obnoxious, not only upon the grounds that it pollutes the atmosphere, but even more forcibly because it is evidence of inefficient combustion and the wastage of fuel. Unfortunately, the remedy is not wholly in their hands. Boilers and furnaces can be and are so made that the emission of smoke is needless. But skill is required in their use and in the use of instruments that indicate whether efficient combustion is being attained. Sometimes that skill is absent; sometimes the plant is overdriven. Nor is the only offender smoke. Whether or not a chimney is emitting smoke the gases will contain sulphur fumes, and those fumes may well be more deleterious to health than smoke itself. For in damp conditions, even if the meteorological situation is not conducive to the formation of "smog," sulphuric acid may be produced. The scale of the consequent damage done to buildings is incalculable. The cost of upkeep of buildings in smoky cities is certainly very much higher than elsewhere. But save only in great power stations it is impracticable to remove the sulphur compounds from the gases.

On no point, probably, is there less agreement than upon the contributions power station flue gases make to air pollution. At Battersea power station, London, the flue gases are washed; and flue gas washing plant was originally installed at the nearby Fulham station, but was taken out of use during the war and never reinstated. The cost of washing is high. It is estimated to be equivalent to about 8s. to 10s. per ton of coal burnt, a very material addition to the cost of generating power. Moreover, the British Electricity Authority contends that washing has disadvantages as well as advantages, and that the discharge of hot unwashed gases from high chimneys ensures a wider dispersal of the fumes than is attainable with the cooler washed gases. It is, in fact, its view that it is not the amount of sulphur dioxide discharged that matters; but the concentration of that gas in any area, and that the concentrations will be less if the gases are discharged hot from high chimneys. There is also some evidence to show that during at least some part of last December's "smog" the high chimney tops at Battersea and Fulham were above the fog belt and the gases were being dissipated by a breeze. We are not, here, going to enter into any controversy as to whether power station flue gases ought to be washed or not, beyond remarking that it is a material point that, where there is a group of power stations close together in a large city, the Authority's argument may lose some of its force. Certainly the London County Council believes it does. But the controversy can only be settled if and when more facts become available. Moreover, the whole subject of the prevention of air pollution can almost be regarded as *sub judice* at present in consequence of the setting up last July (at the instigation of the London County Council) of the Beaver Committee. That Council decided last Tuesday to submit written evidence to the Committee. It recommends that investigations should be made of a number of subjects, including that of the value of washing flue gases, that there should be a strengthening of the laws relating to smoke emission and of the powers of local authorities, and that a number of other actions should be taken, including that of making more ample supplies of smokeless fuel available. Everyone will look forward to the issue of the Beaver Report. But no one who has examined the problem can have any illusions that "smogs" in London can be either easily or quickly eradicated. The best that can be hoped for is that as the years pass the means will be found to reduce their toxic and damaging nature. At least there is now public appreciation that last year's "smog" created a disaster of the first magnitude, and that a similar disaster may occur in any of the winter months of years to come unless action is taken to prevent it. Londoners can no longer take a silly pride as they used to do in the discomforts of a "London Particular."

WHY AND WHY NOT?

It is, no doubt, very flattering to grown-up vanity that children so often assume that everything is known to adults. But it is not without its embarrassments. For a childish "Why?" can not only often reveal to us

how limited our knowledge really is (which we know already) but, what is worse, to what a high degree we have come to accept certain things as normal and no longer open to further debate. We cannot at once even answer simple questions within our own fields of study, let alone others. "How big are that engine's wheels, Daddy?" "About six feet." "Why are they about six feet, Daddy?" How many of us would find an immediate and sensible answer to that question if it were suddenly flung at us on a railway platform? Of course, given time for reflection we can think out the answer to that, as to many other queries. But the thinking out often leads us to ask a lot more questions of ourselves, and much more subtle questions than a small boy (thank Heaven!) is likely to ask. Moreover, the asking of "Why?" may lead us to consider the more constructive "Why not?" For it is probable that there have been many developments since we last studied those questions, perhaps very many years ago, when we were little more than boys ourselves. We may find ourselves asking (and not knowing the answers) such questions as "Why do we not use this new material?" or "Why do we not adopt a new manufacturing technique for that awkward part?" But if an uninformed child can set going so constructive a train of thought, how very much more effectively can an informed man do the same! Men who are expert in their subjects, but have nevertheless managed to keep alive within them the childish instinct perpetually to be asking "Why?" and who have cultivated also the more imaginative, more grown-up and more constructive habit of asking "Why not?" are immensely valuable.

There are fashions even in technical thinking. The success, for example, of a new material in a prominent application may lead to its use in other applications for which its advantages are much less marked or even non-existent. Research workers, excited by discoveries in one field, may concentrate upon it to the exclusion of the study of other fields equally promising but less advanced. Obsessed by a desire to raise productivity engineers may lose sight of a loss of flexibility or even fail to calculate its economics. For often the gains that prove so pleasing on the swings are counterbalanced by hidden losses on the roundabouts. To be working along a line long since accepted as a good one and to be suddenly asked "Why?" is undoubtedly very annoying and sometimes disturbing. But it is also very salutary. For it is very easy to become so immersed in solving detail problems that sight is lost of the original broader purpose, once so clearly seen, for which their study was undertaken. At most it does no one any harm to have to justify once more the assumptions that led him to work upon a particular line; at best some more fruitful method of approaching the main problem may be suggested. It is, we suppose, rather improbable that the questions asked by Mr. Mitchell about pre-refining and duplexing, in his lecture on "Steel-making Processes," which we reproduce on another page, will reverse a trend. But it is certain that they will cause the problem to be better studied "in the round" instead of rather exclusively, as it affects the melting furnace. Moreover, his "Why not?", implied in the suggestion that "where blast-furnaces and steel works are depending on a mixed variety of ores, with varying phosphorus contents, it is possible that the tonnage of each type available could be segregated in order to produce two distinct types of iron, each suitable for a different method of steel-making" has a broader relevance than to the steel industry alone. There are advantages in standardisation upon a single product. But they should not be allowed to go unquestioned. It cannot invariably be assumed that extreme simplification will lead to extreme economies.

In no field to-day is it more important to ask "Why?" and the more suggestive "Why not?" than in that of productivity. Material of immense value about American methods of manufacture has been brought back to this country by productivity teams. But it still needs stressing that those methods, instructive and suggestive as they are, are not necessarily applicable without modification here. Maybe the iron and steel productivity team was right to recommend that blast-furnaces with large-diameter hearths comparable with those seen in America should be built in this country. But heed should be taken of Mr. Mitchell's warning. "An approach based exclusively on productivity and capital costs is not necessarily correct." For a true assessment of advantages and disadvantages the blast-furnace cannot be studied in isolation from the steel-making unit and the rolling mills. Similarly in engineering, a true assessment of the applicability of American methods of production cannot be made without taking into account British economic conditions, the psychology of the British working man, and above all, the need in competitive markets of meeting the customer's desires.

Literature

Stress Waves in Solids. By H. KOLSKY. London: Oxford University Press, Amen House, Warwick Square, E.C.4. Price 25s.

IN recent years there has been a revival of interest in problems of stress propagation, and several aspects of the work are clearly of great importance in engineering practice. Hitherto, the state of the literature has made these problems the concern of relatively few specialists. For it has been scattered through a very wide range of scientific journals, so that this book's list of references is more than usually important. To quote the author, "The purpose of this monograph is to give a concise account of the classical theory [of elastic bodies], to consider how this theory has been extended to solids which are not perfectly elastic, and then to summarise the experimental work carried out in recent years." The book (which is one of the "Monographs on the Physics and Chemistry of Materials" Series) is divided into two parts, the first dealing with perfectly and the second with imperfectly elastic media.

Part I starts with a lucid introduction to propagation in the infinite solid, including some discussion of the æolotropic medium. The effects of introducing a plane boundary in an isotropic solid are discussed with a description of Rayleigh waves and reflection phenomena. The problem of reflection and refraction at an interface between two semi-infinite, isotropic media is also dealt with. A survey is made of stress propagation in bounded isotropic solids (rods and plates) in which the salient features of exact theory are examined together with a discussion of elementary engineering theories and the ways in which the latter approximate to the former. Finally, some of the most important experimental investigations with isotropic elastic materials are described. They include the well-known pressure bar experiments of Bertram Hopkinson and of R. M. Davies. An all-too-brief discussion of some recent work in ultrasonics is given.

The second part of the book commences with a chapter on internal friction and viscoelasticity. The author then takes up the problem of experimental determination of dynamic elastic properties of materials and discusses results. This is followed by an interesting treatment of plastic and shock waves in solids covering the theories of G. I. Taylor, Th. von Kármán and K. A. Rakhmatulin for the infinite wire. The final topic is the important one of fractures produced by stress waves in which mention is made of the work of J. Hopkinson, B. Hopkinson and G. I. Taylor, as well as a description of some recent, fine work done by the author and D. G. Christie. This last chapter is of particular importance to the engineer.

Only simple mathematics is used throughout the book and a clear notation is employed. Fortunately, the author has not seen fit to indulge in the use of matrix methods, and elasticity equations are presented in component form after the manner of Timoshenko. Vectors are mentioned in an appendix, as are curvilinear orthogonal co-ordinates.

Fundamentally, this is a *physics* book and the list of references represents a judicious selection for this purpose. The author contrives to keep in constant touch with physical reality so that his book is far from being one of applied mathematics alone. These two merits will attract the engineer and provide him, not only with a good account of the fundamentals of stress propagation, but also with a valuable introduction to the literature. As pointed out earlier, stress waves have become an object of renewed interest. An additional, up-to-date survey of the field is given in an article by R. M. Davies in *Applied Mechanics Reviews*, January, 1953.

Jane's Fighting Ships, 1953–54. Edited by R. V. B. BLACKMAN. London: Sampson Low, Marston and Co., Ltd. 25, Gilbert Street, W.1. Price £4 4s.

Jane's Fighting Ships has for many years been regarded as a reliable and up-to-date work of reference on the navies of the world and the 1953–54 edition, recently published, is no exception. Over 600 new illustrations have been inserted, either as additions to, or replacements of, photographs in the 1952–53 edition, bringing the total number of illustrations up to about 2500. A normal and always useful feature of *Jane's* is the foreword by the publishers, summarising the main changes and developments in the principal navies. This year special attention is drawn to three new developments—atomic propulsion, ship specialisation and guided missiles—and it is suggested that they may ultimately have far-reaching effects on the composition of navies and naval operations. There is, indeed, little reason to doubt this forecast as regards guided missiles, but the overall effects of atomic propulsion and ship specialisation may well be less revolutionary than is generally believed. Atomic propulsion will, it is true, enable ships to travel vast distances without refuelling. But is this such a great advantage in view of the sacrifices in armament and armour which

are likely to be required, to make room for a nuclear plant and the necessary shielding ? Refuelling at sea, moreover, is now a recognised practice—the United States 6th Fleet in the Mediterranean indeed depends on it. Only in the case of submarines is the advantage of atomic propulsion beyond question—not because of the long distances they will be able to travel but because atomic propulsion dispenses with the snort and transforms submarines into vessels which habitually navigate submerged at high speed instead of submerging only when the need arises.

Equally the significance of ship specialisation can be over-emphasised. Ships are designed for a primary purpose—either to gain control of the sea routes or to safeguard them once control has been gained. And it is this function which determines their design. Special equipment may be required for particular duties—equipment which, incidentally, can be removed by a brief visit to a dockyard—but there seems no good reason to adopt the American habit of classifying vessels according to the particular job for which they are earmarked. A submarine remains a submarine whether she is a radar picket, mine-laying or " hunter-killer " vessel.

The publishers are, however, on firm ground in their comments on guided missiles. If developments continue on present lines, the large bombardment or artillery-guided missile seems likely to replace both the bomber for strategical bombing and the strike aircraft and large shell for actions between ships. Its large size and its range of some 500 miles indicate that it will be a missile primarily of use for seapower, to be launched, as *Jane's* suggests, from big ships.

Apart from indicating progress in the building of fast frigates and minesweepers, the British Navy section contains little information which is new. This is not the fault of *Jane's*, for no fighting ship larger than a frigate has been laid down since the war. Meanwhile most of our existing carriers and cruisers are approaching the end of their normal life of twenty years and unless a replacement programme is begun without delay we shall have only two fleet carriers and five cruisers in 1960 which are less than eighteen years old. This, of course, omits the three " Defence " class cruisers whose construction has been suspended for the past three years, pending a decision on their armament. The United States Navy, on the other hand, not only continues to add ships to her already enormous navy—including two submarines with nuclear plants and two 60,000-ton carriers—but has already converted several ships for firing guided missiles. Indeed, almost every page of the United States Navy section teems with interest. No mention is made in this edition of new Russian battleships; the number of submarines in commission is stated to be 370, with a further 100 building. These figures are in line with authoritative estimates announced in the United States, but many of these vessels now in service are small and old and quite unsuitable for operations on the trade routes. There is also a good photograph of the cruiser " Sverdlov "—which made such an excellent impression at the Coronation Naval Review—and seven more of these powerful 35-knot ships are stated to be under construction. With the completion of these ships, the Russian Navy will have a total of fifteen modern cruisers.

Other new matters of special interest are two sections on the German and Japanese navies. There are in fact two German fleets, West and East ; both consisting of coastal craft, minesweepers and other small vessels. The Japanese Navy now includes eighteen frigates and fifty-four gunboats obtained from the United States, in addition to a large number of smaller craft. The pages dealing with the Dominion Navies are also worth close study. Their navies are expanding rapidly and already provide a substantial addition to the seapower of the Commonwealth.

Lubricant Testing. By E. G. ELLIS. Wellington, Shropshire : Scientific Publications (Great Britain), Ltd. Price 37s. 6d.

BECAUSE lubricating oil is a complex mixture of hydrocarbons which cannot be resolved into its individual constituents, the problem of ensuring consistent quality of supplies cannot be solved by chemical analysis. Physical and functional tests are essential and numerous methods, many of them empirical in character, have been standardised by such bodies as the Institute of Petroleum. At first sight it would appear that the collections of standards published by these bodies provide the lubricant technologist with all the information he would require. However, without further insight into the considerations underlying the definition of the various test methods, the experimenter may well be led into gross errors of interpretation. The present book aims at eliminating this risk. It presents the information in a logical and readable form.

This is particularly the case in Chapters II and III, which deal with the determination of viscosity of oils and greases respectively. Attention is drawn to the complicated flow properties of lubricating greases. Determination of viscosity by ordinary means is not possible because the relation between rate of flow and shearing force no longer follows the simple Newtonian laws. Various rheometers are described and caution is urged in control of variables and in interpretation of results. For example, it is pointed out that the standard penetration test for greases often gives poor reproducibility. This may be because of such factors as the presence of air bubbles or slight damage to the tip of the cone.

In Chapter VIII the most popular of the current theories of friction are outlined and the various forms of so-called extreme pressure testing machines are described. But it cannot be conceded that the space devoted to the various types is representative of their value. For example, there can surely be little justification for devoting four times as much space to the Falex machine as to the elegant and efficient four-ball machine of Boerlage.

The level of lubricant technology is not yet sufficiently high to enable performance to be predicted from measurement of physical and chemical properties. Functional tests are essential and the book comprises what is possibly the best collection of descriptions of machines used to simulate the conditions of practice. Whilst reproducibility of a bearing grease may be assured by rheological tests, we do not yet know how to define the qualities required for a new formulation to be successful in a bearing. Each bearing manufacturer has his own procedure for mechanical testing of greases and bases his recommendations for brands suitable for use in his bearings on the results obtained therefrom. Unfortunately, the procedures differ, so that, in order to cover the field adequately, a grease manufacturer would need to have at least three expensive testing machines. These are fully described, but it is to be regretted that agreement on a standardised test has not been reached in time for a description to be included in the present book. It is to be hoped that this will be possible in a second edition.

The testing of crankcase oils in engines is dealt with in Chapter X. The history of the use of the Caterpillar single-cylinder diesel engine is referred to together with the companion Chevrolet test required in current British and American Specifications. The engines used are commercial American ones not easily obtainable in this country, and they do not always represent British practice. The Engine Test of Lubricants Panel of the Institute of Petroleum has therefore sponsored the development of two engines, the " Sunbury " and the " Shell Ricardo." These are described in the book together with the potentially valuable independent effort of BLOGRA. It is, however, to be regretted that this valuable chapter is not completed by a description of the use of the Petter " AV1 " and other small test engines now being used as " sorting tests."

Another notable omission is that of any serious treatment of the C.R.C. methods for evaluation of back axle lubricants. Whilst it is true that these tests are not at present practised in this country, the needs of inter-service standardisation and the desirability of building up the export trade in lubricant additives make it necessary for U.K. experts to have this information.

Three-quarters of the pages of the book are devoted to physical or functional tests as distinct from chemical matters. There can be no quarrel with this emphasis, which represents fairly the present state of the art. But it is surprising to find that the author addresses his book to " chemists who are in charge of laboratories " and only incidentally to " engineers and others on the technical sales side." The present state of the art of lubricant testing reveals the failure of the chemist, and it is clear that the engineer and the physicist should now occupy the predominant place in the determination of the fitness of a lubricant for service. The latter will find the book just as useful as the former.

Materials Handling. By JOHN R. IMMER. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 57s. 6d.

FOR human rather than economic reasons, the introduction of mechanisation is not always an easy matter. It may on occasion displace labour. Certainly it calls for major changes in generally accepted practice. If advantage is taken of all the ideas offering it may even call for a higher standard amongst the humans who are called upon to operate it. Professor Immer in his book has not only carried out a major task of co-ordination of information, but he has done it in a readable and acceptable manner and he shows a very deep knowledge of his subject. The reader who is interested in a particular aspect of the subject will find it easy to obtain the information he requires, assisted by the fact that the book is well printed and illustrated.

There is a total of thirty-four chapters, divided into seven parts and followed by an Appendix, containing a useful classification for materials handling information, a list of references for specific industries and a list of visual aids, and the index is thorough. Every chapter of the book is clearly illustrated, both by half-tone blocks and attractive diagrammatic drawings. Some of these illustrations are original, but obviously many have been supplied by companies interested in materials handling. At the end of each chapter there is a summary under two heads which are intended to stimulate the reader's imagination. The

first is listed under " Questions " and suggests to the reader certain items which should be investigated further, and these tie in with " Projects for Further Study." Both " Questions " and " Projects for Further Study " are likely to be of interest to those concerned with the training of young human material in mechanical handling technique ; in particular those coming within the scope of the syllabus for the training of ships' officers in cargo handling, now being prepared by the International Cargo Handling Co-ordination Association, of which Professor Immer is a founder member.

Each section of the book is complete in itself. Indeed, *Materials Handling* is a study which, before very long, may well have to split itself off into seven volumes under one omnibus title. Immer takes us back to the genesis of his subject with an introductory section, including sketches of some of the very earliest known methods of mechanical handling. Part II—" Motion and Time Study "—is a matter which the author has made particularly his own. He lectured and broadcast on this subject when resident in this country as a research scholar at Oxford University. An appreciation of the scope of treatment of the subject as a whole may be gathered by the fact that in Part III under the title " Materials Handling Equipment " there are six different chapters, each covering a separate aspect of movement. In Part IV we read about packaging in three chapters. To many people packaging is a subject by itself, having no relation whatever to cargo handling. Immer indicates, particularly in Chapter 15, in dealing with research in packaging and materials handling, how attention to packaging can speed cargo movement. In Part V, under the generic title " Analysis," the author discusses such matters as cost accounting systems, determination of handling costs and how to sell better handling methods. Again, some people might well be of the opinion that this is a subject by itself, but Immer shows how necessary it is—in seeing the broad picture—to have an appreciation of the matters outlined in the six chapters in this section, as, indeed, in the same number of chapters in Part VI, which deals with organisation.

In Part VII in seven chapters the author gets down to specialist details. Airmen, railroad men and shipping men, as well as specialists in bulk cargo handling, might each consider that their individual problems were so great that they could not possibly be integrated into materials handling as a whole. Yet Immer shows that this is, indeed, the case.

The book is made the more valuable by generous references to sources of information. It should be on the bookshelf of anyone concerned in major or minor extent, with the moving of " things " from place to place in the most expeditious and efficient manner.

Chemical Engineering Techniques. By B. E. LAUER and R. F. HECKMAN. New York : Reinhold Publishing Corporation, 330, West 42nd Street. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 48s.

THE preface of this book begins with the observation that " many chemical engineering students spend a large share of their college careers without ever being fully aware that there is a systematic arrangement of the methods of chemical engineering." The authors then go on to explain that the purpose of the book is " to point out the basic objectives of chemical engineering and to present some of the more important techniques . . . grouped on a functional basis with respect to their objectives." The use of the word " techniques " in this way should not be allowed to mislead the reader, for this is an elementary book, devoid of mathematical and chemical equations and containing few quantitative data. The material has been carefully classified in a way that is logical and reasonably complete, and many of the sections contain detailed check lists. Students, especially the less experienced ones, are likely to find these two merits the most valuable in the volume, since they enable it to be used as a general and easily-read survey of the subject and as a guide to wider reading. The advantages and disadvantages of a number of items of equipment have been listed. Inexperienced students will find this another useful arrangement, because it will help them to see why one sort of equipment may be preferred to another for some specific duty ; and conversely, that there is sometimes more than one way of reaching the desired end.

The authors are at their happiest when dealing with items of plant that have become familiar in the practice of mechanical engineering. Their treatment of electrical and chemical plant is by comparison short and sometimes superficial ; for example, electrolytic reactions receive less than one page in the chapter on reaction vessels.

It is regrettable that so many of the illustrations, including the coloured frontispiece, contribute to the merciless price of the volume without adding much to its real worth. This criticism is also unhappily true of a few sections which seem to have been included for the sake of completeness ; it is surely carrying this principle to the point of quixotism to attempt to deal, within the compass of fourteen pages, with the vast and detached subject of chemical and physical analysis and testing. If it were not for its cost, the book could be well recommended to the beginner in chemical engineering and to the general reader.

SHORT NOTICES

Un Demi Siècle de Progrès Dans Les Travaux Publics et le Batiment. Paris : Le Moniteur des Travaux et du Bâtiment, 32, Rue Le Peletier 1X^e. Price 1250 francs.—The French journal, *Le Moniteur des Travaux et du Bâtiment*, has published this volume to commemorate its fiftieth anniversary. The progress which has been made in the civil engineering and building industries during the past fifty years forms the theme of the book, which comprises a series of articles, each contributed by a well-known French authority. For instance, the first of them is entitled " L'industrie francaise des Travaux Publics," and is by Monsieur Dehe, president of the French federation of civil engineering contractors. Subsequent articles deal with the technical progress in specific branches of building and civil engineering—including, to give one instance, an article on the manufacture of building materials—or with general questions, such as the organisation of the building trade or the rôle of the architect, or with historical reviews covering the fifty years' progress and achievements in various fields, such as in the construction of railway bridges, or of hydro-electric schemes. Seen in this manner, the French contribution to civil engineering construction is impressive, and there are many fine examples of such work given in the various articles.

Circuit Breaking. Edited by H. Trencham, M.I.C.E., M.I.E.E. London : Butterworths Scientific Publications, 88, Kingsway, W.C.2. Price 30s.—A series of six lectures dealing with research on circuit breaking as carried out by the Electrical Research Association was given last year, first at the Polytechnic, Regent Street, and, later, at the Armstrong College, Newcastle upon Tyne. These lectures have now been published in the book under review. In the first lecture, Dr. W. Bevan Whitney discussed the aims, achievements and problems of the E.R.A.'s work. The second lecture presented an introduction to the theory of circuit breaking, by Mr. A. Morris Cassie. Mr. L. Gosland then dealt with circuit constants in relation to circuit breaking, and Dr. C. E. R. Bruce discussed electrical discharges in relation to circuit breaking. Electrical methods and techniques in circuit breaker research formed the subject of the fifth lecture, which was given by Mr. F. O. Mason. Finally, the impact of the E.R.A. research on circuit breaking practice was reviewed by Mr. H. Trencham : as the only one of the lecturers who was not on the E.R.A. staff his was the task of concluding the series and of editing the book. The text adheres closely to the talks as delivered, with minor changes to suit the written, as against the spoken word, and to allow for the fact that some of the lectures were accompanied by exhibits of apparatus and demonstrations.

BOOKS RECEIVED

The Atomisation of Liquid Fuels. By E. Giffen. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 36s.

Fundamentals of Physical Metallurgy. By Ralph Hultgren. London : Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, W.1. Price 70s.

Alternating Current Electrical Engineering. By Philip Kemp. Eighth edition. London : Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 36s.

Engineering Law. By R. E. Laidlaw and C. R. Young. Fourth edition. London : Oxford University Press, Amen House, Warwick Square, E.C.4. Price 38s.

Automatic Digital Calculators. By Andrew D. Booth and Kathleen H. V. Booth. London : Butterworth's Scientific Publications, 88, Kingsway, W.C.2. Price 32s.

The Design of Valves and Fittings. By G. H. Pearson. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 50s.

Practical Jig and Tool Making. By Robert S. Connell. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 12s. 6d.

Metal Industry Handbook and Directory. Forty-second publication. Liverpool : Blackwell's Metallurgical Works, Ltd., Thermetal House, Garston, Liverpool, 19.

Properties of Metallic Surfaces. A symposium organised by the Institute of Metals. London : The Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 35s.

The Joining of Metals. Lectures delivered at the Institution's Refresher Course, 1951. London : The Institution of Metallurgists, 4, Grosvenor Gardens, S.W.1. Price 14s.

The British Industrial Measuring and Control Apparatus Manufacturers' Association : Handbook, 1953. London : B.I.M.C.A.M., 21, Tothill Street, Westminster, S.W.1.

Metal Turning Made Easy. By Eric Franklin. Second edition. London : Cassell and Co., Ltd., 37/38, St. Andrew's Hill, Queen Victoria Street, E.C.4. Price 4s. 6d.

Road Making and Road Using. By T. Salkield. Fourth edition. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 22s. 6d.

The Principles and Practice of Surveying. By Charles B. Breed and George L. Hosmer. Seventh edition. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 56s.

The Metallurgy of the Rarer Metals. Lectures delivered at the Institution's Refresher Course, 1952. London : The Institution of Metallurgists, 4, Grosvenor Gardens, S.W.1. Price 15s. 6d.

Physics. Vol. I, Part I, *Mechanics.* Vol. I, Part II, *Heat.* Vol. I, Part III, *Properties of Matter and Sound.* By L. S. Powell. London : Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 5s. each.

TUBULAR STEEL FACTORY.—In last week's issue of THE ENGINEER a description of the structure of the new factory of Tubewrights, Ltd., at the Kirkby Trading Estate, Liverpool, was given on page 626. At the end of that article an error was made in stating the production figures for the new factory, and the correct figures are given herewith. It is expected that, at first, production will be at the rate of about 7000 tons to 8000 tons of fabricated tubular steel products per annum, but it is possible that with double shift working, improved manufacturing procedures, and an extension which is at present envisaged, production could rise considerably above these amounts.

Two Marine Water-Tube Boilers

INSTITUTION OF MECHANICAL ENGINEERS

AT a general meeting of the Institution of Mechanical Engineers, which was held in London last Friday, November 13th, a paper entitled "The Synthesis of Two Marine Water-Tube Boilers" was read by Commander (E) L. Baker, D.Sc., R.N., ret. An abstract appears on page 663. Mr. I. V. Robinson, chairman of the steam group, presided. The following discussion took place.

Discussion

Mr. H. N. Pemberton recalled that the author said that his primary reason for adopting water-cooled furnaces in the main boilers was to eliminate refractories in positions of high heat stress, and from the photographs and sketches shown in the paper it looked as though the water wall tubes were not in actual contact with the refractory bricks. Perhaps the author would say whether this was indeed the case, since he (Mr. Pemberton) believed that this did influence the life of the bricks by tending to prevent spalling and other heat effects. He had no doubt that only by using water walls had the author been able to obtain such a compact furnace of only 6ft length. The furnace floor and front walls of the main boiler were not water cooled, and he was particularly interested in the condition of the floor brickwork where it rose up to protect the surface of the bottom water drum.

Two slides which were shown illustrated what could happen to the bottom water drum if that particular part of the brickwork was not well maintained and kept right up to its job. Slide 1 showed the surface of the drum in a modern water-tube boiler, along which could be seen the very large number of circumferential surface cracks. There was also a tide mark shown, which indicated that the brickwork had not protected the surface of the drum on that surface. Slide 2 showed a close-up of a crack which went right through the drum shell. That was a most recent happening in a modern water-tube boiler less than five years old, and the real cause of this had still to be investigated.

Mr. E. H. Smith said that when his firm had received the outline and basis drawings they had looked a complicated proposition, but he confirmed, from first-hand experience, that the boilers had been found to be very simple to manufacture, and he found that it could almost be taken as an axiom that simplicity in manufacture would generally result in ease in maintenance.

A most attractive feature of the design from the manufacturing point of view was the separation of the superheater from the steam generating surface, and especially for the relatively high steam temperature employed, where it was preferred to employ an all-welded design in the third stage. The actual work of welding up the superheater elements had been carried out by the oxy-acetylene process by the regular boiler shop welders, and he thought it had been confirmed as being entirely satisfactory.

Although these boilers had been almost entirely free of gas leaks in the casings, he wondered whether there would be some advantage in using reduced pressure steam for soot blowing, for with boilers of higher pressure, such as 650 lb or 625 lb pressure, it seemed that there might be some advantage from the point of view of maintenance in using reduced steam for that purpose.

There was as yet only a very limited amount of information available about bled steam heaters, but he thought that they involved some small loss in overall efficiency to reconcile all the conflicting factors of bled steam feed heating and the extent to which one was going to introduce economiser surface. With regard to the electronic high-level water alarm, it would be interesting to know whether this had ever been brought into operation, and whether there was any possibility of the probe being short-circuited either by the quality of the steam or possibly by moisture condensing on the probe and short circuiting it to earth.

A controversial point was the adoption of a relatively complicated forced circulation boiler for the dirty steam duties of the ship, particularly the heating of the oil fuel bunkers and the settling tanks. For his part, he preferred the old-fashioned arrangement of having a steam-to-steam generator for sea service and a vertical fire-tube boiler for port service.

Mr. R. E. Zoller mentioned that the paper said: "The majority of marine water-tube boilers prior to 1930 were in service in one or other of the world's navies . . ." This he doubted, and gave the following figures:—Up to 1938, ocean-going passenger ships, 666; cargo steamers, 164; cross-channel steamers, 36; dredgers, 66; tugs, 79; cargo boats, 216; yachts, 22; others, 73; giving a total of 1409. The corresponding number of naval vessels was 635, which, he thought, was not quite a "majority."

Another thing which he thought was misleading was the statement ". . . the most usual British practice being two-stage heating, which raises the temperature to about 275 deg. Fah." For the last one hundred jobs for which his firm had had orders the feed temperatures had been as follows:—400 deg., seven; 360 deg., one; 340 deg., two; 320 deg., forty-three; 310 deg., eight; 300 deg., eighteen; 280 deg., seven; 240 deg., eleven; 220 deg., four. In other words, the trend was not at about 275 deg. Fah.

Could the author give information on the weight of the boilers, including the superheaters, economisers, desuperheaters, and so on, since information on that matter would assist a comparison being made with other ships?

The author stated that the air heater, economiser and superheater were arranged for washing. That type of vertical-tube air heater was not the best for washing. There were many cases with these vertical tubes where one could have quite a few tubes choked right across with sodium sulphate and similar deposits which were only slightly soluble in warm water. Once a tube was choked, one could wash as much as one liked, but in the end it would be necessary to have the tube out. With a horizontal tube, with the air going through the tube, one could get it partially choked, but it could not become choked entirely. He therefore thought that there were some things which could be said in favour of this tube which could not be said in favour of the other.

Mr. Hayden said he wished to remind the author that one reason for placing the superheater completely outside the boiler was to make it easily washed without flooding the boiler heating surfaces. The whole of the casings surrounding the superheater were lined with plastic refractory, especially resistant against water.

He wished that all the predictions made in the design stages had turned out as well as the furnace size. For instance, the superheat of 950 deg. Fah. had not been realised on the voyage of the first vessel, due to the incorrect estimation of the gas temperature entering the lower section of the superheater and had now been corrected by the removal of boiler heating surface. There had also been some difficulty, when the gas temperature to the superheater had been increased, in obtaining the minimum superheat of 750 deg. Fah. under full-load conditions, due to the leakage past the dampers above the first section of the superheater. These dampers had been made with considerable clearances around their edges so as to leave freedom for expansion, and the amount of gas flowing past those clearances and over the lower section of superheater had added more heat than was originally anticipated. Landing strips and sealing strips had been added and had corrected this fault.

In his opinion marine boilers were far behind the standard of starting-up and control gear fitted to gas turbines, aircraft, diesel engines, and motor-cars, and that a considerable amount of work could reasonably be directed towards the development of a reliable set of lighting-up and control gear for oil firing equipment.

Mr. R. G. G. Richardson said it was of interest to learn that a total steam temperature of 950 deg. Fah. could be obtained with a superheater completely behind the boiler generating surface. This placed the superheater in a cooler and thereby safer zone, as it was not subject to direct radiation and had a further advantage in that the superheater could be supported from beams attached to the boiler casing structure.

The control of steam temperature by dampers regulating the flow of gas over, or by-passing, the superheater had been used in many installations, but the design of dampers had not always been as good as was possible, and many complaints against them had been made in respect of faulty bearings, on which the damper spindle swung, and also the distortion of the dampers, resulting in excessive gas leakage even with the damper in the closed position.

In the arrangement described in the paper a dual system of steam temperature control had been provided, i.e. gas dampers plus an air attemperator. Would the author after operational experience consider steam temperature control by gas dampers alone?

With such an alternative arrangement the attemperator with its necessary ancillary equipment could be dispensed with. The dampers, placed athwartships and in the uptake, would extend the full width of the superheater duct, and possibly give a greater measure of control of superheat than occurred with the present arrangement.

The advantages could be: (1) a wider range of steam temperature control by the fact that the dampers affected the gas flow over the entire superheater surface and not a part only, a given change in gas flow therefore resulting in a greater change in steam temperature; (2) the new arrangement gave an uninterrupted gas flow across the superheater, which should greatly improve the gas distribution across the superheater width and avoid the possibility of local overheating of certain elements; (3) the dampers would be in a zone of much lower gas temperature and therefore should give better service; (4) furthermore, with the arrangement here described, an intermediate header could be

dispensed with, as the second stage outlet header would incorporate the inlets of the third stage elements.

It should be borne in mind that if large heat absorptions were contemplated in the attemperator, the resulting air temperature at the burner registers might be such as to require the air heater to be partially by-passed, thus offsetting any gain in efficiency which would otherwise accrue from the provision of this means of steam temperature control.

The remarks on pressure drop through superheaters and its relation to their safety were interesting and of importance when the present-day demand was for higher pressures and temperatures in marine boilers. The distribution of steam through superheater elements in parallel was dependent upon the pressure drop through the elements in relation to that along the headers, and also upon the position of the branches on the inlet and outlet headers. It was always an advantage to locate these connections in a section of the header where there were no element entries, otherwise local disturbances inside the header could be introduced in the vicinity of the branches, which could affect the distribution of steam through the elements at these points.

Whilst the overall pressure drop would decrease with reduction in load, the relative pressure drop in headers and elements would remain practically constant. The fact that the out-of-balance flow through the individual steam paths was not affected to any large extent by changes in overload evaporations had been proved by practical application, with the exception that there could be a certain instability under conditions of very low steam flow. Hence, the risk of damage to superheater elements for a given design, with a certainty of equal distribution through all elements at maximum, would not increase when the boiler load was reduced below the maximum. In addition to the conditions obtaining at the steam side of the superheater, the gas conditions would be relatively lower and thereby less severe. In practice the gas distribution across a superheater, especially those fitted between the boiler tubes, was often far from uniform and differences in temperature of steam delivery from individual elements could be appreciable from this cause alone.

Mr. F. J. Hutchinson said that he understood that the "D" type marine boilers designed for 80/85,000 lb per hour evaporation at 550 lb per square inch steam pressure had given better performances and greater availability in practice than had other types of boilers, due to the provision of very generously designed, unheated downcomers. These amply rated downcomers would tend to create circulation conditions which were not inferior to the circulation conditions which occurred in boilers designed for forced circulation.

With regard to soot blowers, when considering small boilers the provision of automatic or even remote electrically operated soot blowers must be very questionable. With indifferent operating labour there was something very reassuring in having operated each gun manually and in actually hearing that it was, in fact, operating correctly.

On water treatment, he agreed that with operating conditions up to 550 lb per square inch it might not be necessary to include sulphite treatment, but with steam conditions of 625 lb per square inch and 950 deg. Fah. the oxygen content must be reduced to a low value to prevent acid attack on the steel tubes of the economiser, and the silicon content of the boiler water must also be virtually eliminated to prevent loss of turbine efficiency.

The expanding of tubes, drums and headers was mentioned in the paper, and normal land practice for large boilers of advanced design was tending towards the forging and welding of all the tube connections to drums and headers. These methods of connection would probably increase the initial cost of marine equipment, but would result in decreased maintenance charges.

Mr. Taylor said he wished to refer to the deterioration of the boiler refractories, the renewal of which was costly. The author had maintained the conventional method of attaching the brickwork lining by bolts through the centre of square blocks. The B.S.R.A. had come to the conclusion that refractory blocks behind closely pitched water tubes of the type fitted in this boiler should last as long as the boiler itself, providing that a satisfactory method could be found to fasten the things up. He would suggest, therefore, that the use of brick bolts could be dispensed with altogether and the refractory lining could be carried right up to the tubes themselves.

He had been interested to hear of the extremely short furnace which it had been possible to use, and would be interested to know what was the forcing rate at normal power and at the reduced powers during manœuvring. With the very high proportion of water-cooled surface to refractory surface there must be large cooling effects on the flame when manœuvring at very low powers, and one would expect in those conditions to have a longer flame than when operating at high powers in a furnace at a high temperature. This brought him to the question whether, at reduced powers, there was any trouble with unburnt carbon being deposited on the tubes and grit and soot being discharged from the funnel.

Mr. G. A. Plummer said, to his knowledge, sodium sulphite was widely used with every satisfaction in a large number of power stations in this country up to steam pressures of 1500 lb per square inch, and also in a number of marine installations.

He suggested to the author that he was to be congratulated on his choice of engineers who apparently gave superior attention to the operation of the plant. He would point out that while the author was so placed and while his condensers remained tight with satisfactory ejectors, he was nevertheless leaving his boilers in an unguarded position in having no residual deoxidising agent available in the event of any severe gaseous contamination. The maintenance of a small reserve—say, twenty parts per million—of sodium sulphite would, he felt, be justified.

He was aware that the treatment used by the author included the use of sodium carbonate for the provision of alkalinity, but under the boiler temperature and pressure conditions sodium carbonate must be converted to sodium hydroxide, giving off CO_2, which itself was an acidic corrosive gas in the presence of moisture. He also noted that the author referred to an apparatus in the form of a steam sampling fitting, the condensed sample being then passed through an electrical conductivity cell, and drew attention to the fact that this apparatus did not include any means of removing gas in the form of oxygen or CO_2 from the sample. Very small percentages of CO_2 gave rise to a much greater conductivity than did equivalent percentages of boiler salts, so it appeared unlikely that this apparatus would be sufficiently sensitive to provide satisfactory indication of carry-over. A large number of boilers at power stations in this country and a number of marine installations were usin sodium hydroxide for provision of alkalinity in boiler water and thus avoiding unnecessary sources of CO_2.

Commander (E.) L. Baker, in reply, said the general experience with brickwork in these boilers had been particularly satisfactory.

With regard to soot blowers, he thought it was difficult to assess just to what extent the pressure could be reduced without disadvantage to the blowing efficiency, and he was quite certain that the real secret was to get the casings tight first, and then it did not matter very much really what happened inside.

Broadly, the position when bled steam air heaters were adopted was that there was a loss in efficiency of about ½ per cent, and that, of course, was an overall loss on the cycle. On the other hand, one gained complete freedom from any risk of sulphur corrosion at a later stage when undoubtedly the sulphur content of fuels was likely to rise still further.

In response to points made by a number of speakers, he would say that the general experience on the sampling device and the probe had been completely satisfactory and none of the difficulties envisaged by Mr. Plummer had been realised.

By adopting forced circulation boilers for auxiliary steam duties they had saved some 30 tons of weight, equivalent to about 3 per cent on the whole installation.

The dampers on the superheaters were operating in a temperature of about 1500 deg. Fah.; they had a large clearance on the bearings, and so far they had been remarkably free from trouble. The pneumatic controls had no difficulty at all in controlling temperature on the air side, and nor had they any difficulty in pushing the dampers from full open to full shut on the gas side.

A number of speakers had mentioned the economisers. He would confirm that all the designs which had given serious trouble had been steel fin or steel extended surface, and relatively little trouble had been experienced with any cast iron surface design—and none at all on the surface side.

The experience with the commonest fitting in this country was that it was satisfactory only so long as it was left alone. As soon as the maintenance staff got hold of it the standard of boilermaking in the repair squads was so bad that it gave trouble ever afterwards. This was the strongest reason he could advance for cutting out all the clean-out fittings in the economiser, except those that were absolutely essential.

With regard to Mr. Richardson's remarks, he would prefer to leave consideration of the proposed alternative damper arrangement to another time. It required more consideration than he could give it in a brief reply. But he would like to say that he would not consider using dampers alone on the gas side for fine control of steam temperature. They were so satisfied with the attemperator arrangement that he would much prefer to go the other way and do the temperature control on the attemperator.

He agreed with Mr. Zoller that 275 deg. Fah. would be low for a modern design, and said the total weight of each boiler in the working condition was approximately 75 tons, which was very much lighter than customary for boilers of this output in mercantile practice.

With regard to the air heater, the whole point with the vertical tube air heater was not to let it get choked, and with reasonable discipline on a ship that was not a necessity. He agreed, however, that if one was going to let it get choked, a horizontal one would wash clean much more easily.

Power station practice and marine practice were different in so many respects that it was very difficult to compare them without

noticing first all the differences. For example, all the make-up feed in this installation and in all his company's steamships was double distilled. Silica was then very little of a problem.

With regard to the CO_2 sampling, the normal sampling in service was done by a commercial unit which did not give the CO, but the trials on both ships had been carried out with full CO_2 gas analysis, including CO. In practice they were getting between 14½ and 15 per cent of CO_2.

With regard to sulphur variation in the fuels, the sulphur content varied very widely, but the average run of the fuels that were bunkered was now at about 3½ to 4 per cent. Sulphur corrosion of the air heater did occur. By operating with a gas temperature in the outlet from the air heater of about 250 deg. to 260 deg. Fah. with these fuels they had found that they got a life of the air heater tubes of not less than five years.

The steam drum separators were of the perforated plate type, and they appeared to be completely satisfactory. The cycle included, in addition to the de-aeration of the condenser, a shunt de-aerator in the feed cycle and, as far as could be measured, the oxygen content was always less than 0·01 c.c. per litre.

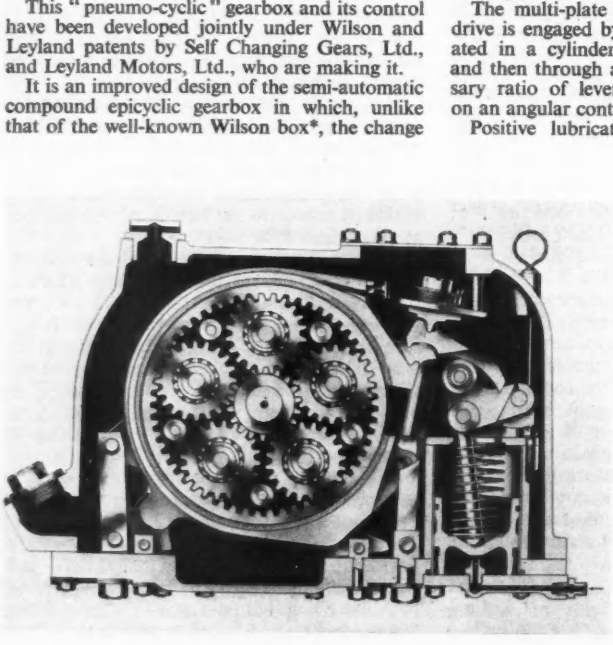
Mr. Taylor had asked for the furnace rating. It was approximately 250,000 B.Th.U. per square foot projected radiant heating surface, and the minimum rating was 1 lb to 1½ lb per square foot. Under those conditions the length of the flame was just unbelievably small. It was certainly not more than 2ft in length, and there was no question at all that the combustion was absolutely complete before the gas left the furnace.

Epicyclic Gearbox without Clutch Pedal

A COMPOUND epicyclic gearbox using a conventional gate and a miniature change speed lever, but with which the gear is pneumatically and simultaneously selected and engaged, has been introduced by Leyland Motors, Ltd.

This "pneumo-cyclic" gearbox and its control have been developed jointly under Wilson and Leyland patents by Self Changing Gears, Ltd., and Leyland Motors, Ltd., who are making it.

It is an improved design of the semi-automatic compound epicyclic gearbox in which, unlike that of the well-known Wilson box*, the change of gear is made solely by the movement of a small gate-change lever, as illustrated. It provides four forward speeds and reverse, the three lower forward gears and the reverse being produced by epicyclic gear trains, each composed of sunwheel, planet wheels and annulus. Top gear, in which the whole of the gearing rotates as a solid unit, is obtained through a multi-plate clutch.



First Speed Train with Pneumatic Actuator

The running gear consists of the four epicyclic gear trains and the input and output shafts. These shafts are carried in the casing in ball bearings, the inner end of the input shaft being spiggoted into the output shaft in phosphor bronze bushes.

The sun wheels of the first and second gear trains are integral with the input shaft whilst the sun wheel of the third speed train revolves on this shaft on phosphor bronze bushes. The drive in each gear is taken through the five-planet-wheel first speed train, the carrier of which is a flange formed on the output shaft. All gearing is made from high tensile steel forgings, hardened and ground where necessary.

The multi-plate clutch which provides direct drive is engaged by an air operated piston situated in a cylinder formed on the front cover and then through a relay lever giving the necessary ratio of leverage, the thrust being taken on an angular contact bearing.

Positive lubrication is provided through a gland on the output shaft and through the shafts to the gear trains and the bearings by a gear pump mounted on the front casing, where it is easily accessible for maintenance.

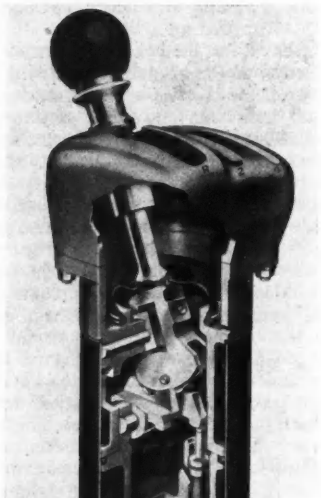
Each indirect gear is engaged by the application of a band brake to its brake drum. A band brake consists of two concentric bands whose friction linings are situated side by side. These linings are made from extremely hard wearing material designed for operation in oil. The outer band, when constricted by the brake mechanism, closes the inner band, both linings thus being brought into contact with the brake drum. Diametrically opposed anchorages are used for the inner and outer bands, thus balancing the brake and preventing the shaft and bearings from being subjected to any load arising from brake application.

When in the "off" position, the brake band assembly is located by centralisers which hold it clear of the drum. Air pressure is used to apply the brakes, a separate air cylinder and actuating mechanism being provided for each brake, as shown in our illustration.

When admitted to the cylinder air forces the piston upwards and the piston rod causes the operating lever to swing about its pivot. A roller attached to this lever moves along the cam face of the thrust pad forcing it upwards, the thrust pad pivoting about its knife-edge on the hooks, thus raising the adjuster mechanism and with it the pull rod which is attached to the outer band lug. As the other end of the band is anchored by the hooks this action constricts the brake band. Air flow to and from the operating cylinders is restricted so as to release one band while progressively applying the band of the gear to be engaged. The restricter orifices are shown in the bottom right-hand corner of our first illustration.

The brake actuating mechanism is the same for all the indirect gears except in regard to the size of the air cylinder and piston. The first speed and reverse mechanisms have the largest diameter cylinders because the greatest torque reaction is produced in these gears.

As the roller of the operating lever moves along the cam face of the thrust pad, the leverage is increased and causes the thrust pad to rise, so increasing the applied pressure on the band. The grip of the band is thus governed by the height to which the thrust pad is allowed to swing.



Gear Change Control Unit

Wear on the brake will cause the thrust pad to move higher and towards the adjuster screw. When this happens the automatic adjuster ring will strike the adjuster screw and will be rotated anti-clockwise. In this event, when the brake returns to the "off" position the adjuster ring will be returned to its normal position by coming into contact with a tail pin, which projects from the gearcase.

The clockwise rotation thus imparted to the adjuster ring is transmitted to the adjuster nut through a coil spring which acts as a one-way clutch. Rotation of the nut reduces the effective length of the pull rod and takes up the extra movement caused by the wear of the brake linings.

* See THE ENGINEER, February 27, 1953, page 313.

Technical Report

The Strength Properties of Timber. Forest Products Research Bulletin No. 28. H.M. Stationery Office. Price 2s.—Laboratory tests of the strength of native-grown and imported softwoods and hardwoods have been carried out at Princes Risborough for twenty-five years. The information so obtained, the Forest Products Research Laboratory points out, is essential for the economical use of wood and the selection of a species for a particular purpose, particularly now that new species of tropical hardwood are being imported and brought into use. The bulletin gives the results of tests of 120 species of timber. The principal strength tests made on timber included static bending, impact bending, compression parallel to grain, hardness, shear parallel to grain and cleavage. The bulletin describes the nature of each test and the procedure used in carrying it out. The test results are given in the form of diagrams, graphs and tables.

Diesel Hydraulic Locomotives for Mauritius

TWO diesel hydraulic locomotives have recently been completed at the Glasgow works of the North British Locomotive Company, Ltd., for the Mauritius Railway and have been undergoing pre-delivery trials in this country. These locomotives are designed for use as single units or in multiple, and they have been built to the requirements of Mr. P. R. I. Cantin, the general manager of the Mauritius Railway and the Crown Agents for the Colonies. They will operate between Port Louis Central Station, Curepipe and Mahebourg, a distance of 32 miles, rising from sea level to 1840ft at Curepipe. On this line the gradients are varying with a maximum of 1 in 26, and a minimum curve of 300ft radius.

Each locomotive is powered by a Paxman "12RPHXL" Series II, twelve cylinder, vee engine with a twelve hour B.S.I. rating of 625 h.p. at 1250 r.p.m. Transmission is by a Voith-North British hydraulic, type "L37ZV" unit with a two-speed final drive. As can be seen from the photograph we reproduce on this page, the locomotives are six coupled, the power being transmitted to the wheels from a jackshaft which drives through side rods. The leading dimensions and some other interesting particulars are given in the following table.

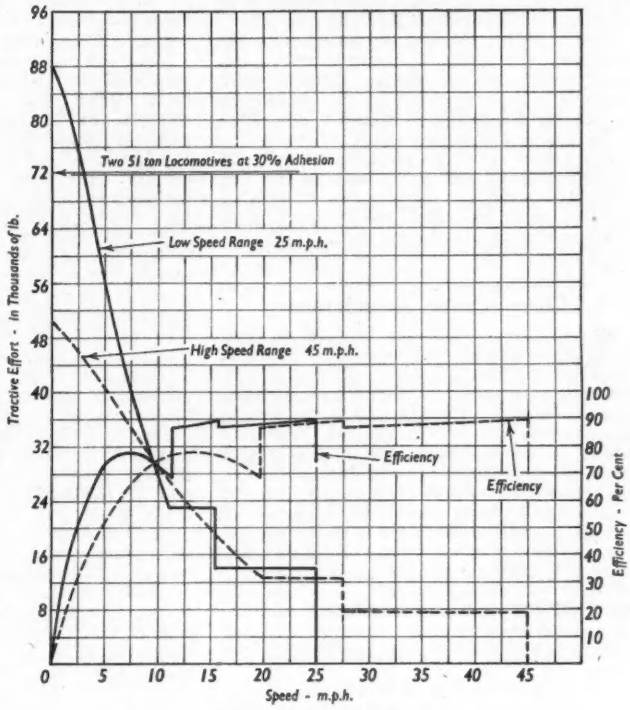
Gauge	4ft 8½in
Length over buffers	29ft 1½in
Maximum height	11ft 6in
Maximum width	8ft 6in
Wheelbase	11ft
Wheel diameter	3ft 6in
Total weight in working order	51 tons
Maximum tractive effort, low speed range	35,800 lb.
Maximum tractive effort, high speed range	23,000 lb.
Maximum speed (low speed range)	25 m.p.h.
Maximum speed (high speed range)	45 m.p.h.
Fuel oil capacity	600 gals.

The locomotive frame is a welded plate structure braced and stayed, the stretchers, brackets and other fittings, which may have to be removed for dismantling and repairs, being secured by fitted bolts. Laminated main bearing springs are compensated on the mid and trailing axles, cab end. Oil lubricated Timken roller bearing axleboxes are mounted on the inside of the wheels and manganese steel liners are fitted to the axleboxes and their guides.

The cab and engine housing are built of mild steel plates and doors provided in the engine housing at the sides and the roof give easy access to the engine. The radiators are arranged on each side of the engine housing, air being drawn in by a vertically mounted engine-driven fan and expelled through the roof of the engine housing. Three sections in the radiators provide for cooling the engine water, engine lubricating oil and transmission oil.

The diesel engine is connected to the transmission through a "Holset" flexible coupling and cardan shaft. Twin Brown Boveri turbo-chargers are fitted, the exhaust manifold connecting with the two turbine inlet ports of each charger, the outlet being ducted through the roof of the locomotive. The air intakes to the turbo-charger are fed through circular filters which are integral with the blower casing. Engine speed is governed by a centrifugal hydraulic governor driven by bevel gearing from the end of the camshaft, and in event of complete lubrication oil failure the engine stops. Engine speed variation is actuated by an air servo piston which is controlled from the cab by a self-lapping throttle valve.

The hydraulic turbo transmission has three fluid circuits; a torque converter for starting and low speeds, and two fluid couplings—one for medium and one for high speed. The torque converter and fluid couplings are self-contained and they are engaged by filling and disengaged by emptying. A fully automatic governor controls engagement, which depends on the speed of the locomotive. Control is operated by the movement of the throttle valve from the engine idling position. This movement energises the solenoid controlling the filling valve and this valve cannot be opened unless the direction lever is in either forward or reverse position. When the filling valve is opened the oil from the pressure pump—which also lubricates the gears, and bearings—supplies oil to the governor, and is directed from there to the converter.

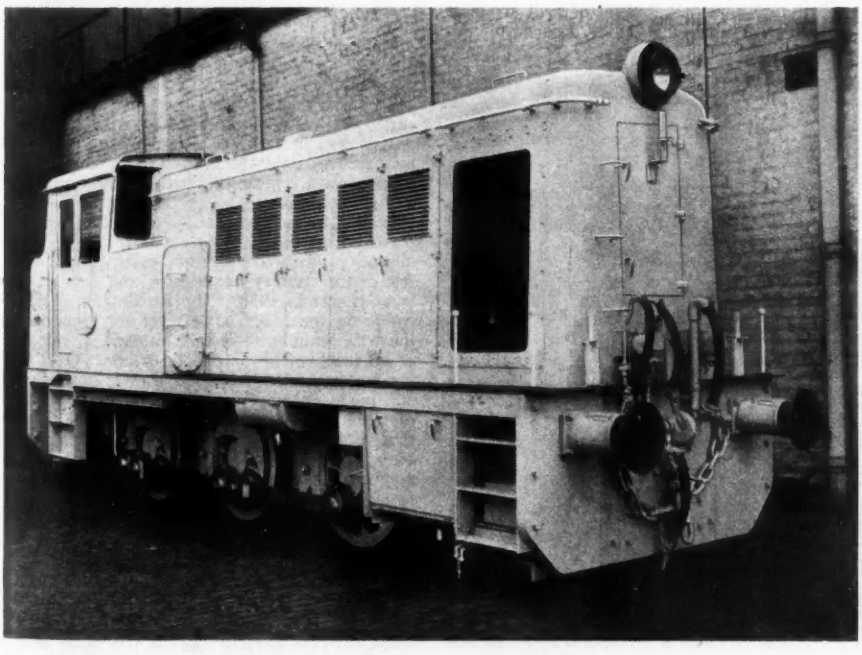

Two 51 ton Locomotives at 30% Adhesion
Low Speed Range 25 m.p.h.
High Speed Range 45 m.p.h.
Efficiency
Efficiency
Tractive Effort - in Thousands of lb.
Efficiency - Per Cent
Speed - m.p.h.
0 5 10 15 20 25 30 35 40 45
8 16 24 32 40 48 56 64 72 80 88 96
10 20 30 40 50 60 70 80 90 100

Tractive Effort/Speed Curve

When the throttle is opened further the engine speed increases until the rail speed actuates the governor; oil is then directed to the first coupling and the converter empties. As the rail speed continues to rise the governor directs the oil to the second coupling and empties the first coupling. This sequence of operations is reversed with the decrease of rail speed, the oil circuits being engaged and disengaged smoothly and automatically. The final drive gearbox, reversing and range changing units are pneumatically operated and are protected by interlocking devices. The engine and transmission are protected by excess temperature pressure switches operating in the water and oil circuits, and a low water switch in the radiator. Should overheating take place the engine speed is reduced to idling and the filling valve closed. Warning lights in the driver's cab also show which section is at fault. With low water conditions the engine cannot be started.

A Westinghouse system of vacuum-controlled straight air brake is fitted, with air brakes on the locomotive and vacuum connections to the train braking system. The air compressor and vacuum exhauster are belt driven from the engine and run at varying speeds according to the speed of the engine crankshaft. The compressed air supply is also used for sanding controls, horn and wind-screen wipers. A deadman control gear automatically reduces the engine revolutions to idling after a delay of approximately five seconds if the driver's foot is removed from a pedal. This pedal is duplicated on each side of the control desk in the cab.

The driver's desk is arranged for driving from each side. Set centrally on the desk are a reversing handle with its indicating lights and a selector handle which has three positions: "off," "engine start" and "control." On each side of the desk are three handles for operating the throttle control valve, the air brake and the vacuum brake, respectively.



Diesel Hydraulic Locomotive

The engine stop-start lever is placed on the right-hand side of the desk. The pneumatic valve for range changing purposes is fitted on the driver's desk and an adjacent indicator shows the position of the gears.

All instruments and warning lights are conveniently grouped on a panel on the cab front plate and electrical switches for the various lights are grouped on the driver's desk. An Elliot speedometer which registers speed and total mileage is fitted. The driver's cab is particularly roomy and its lay-out is such that the controls can be operated in comfort, whilst a good, unobstructed view is given through large windows in each direction of travel.

When used in multiple the locomotives are connected electrically by jumper cable and pneumatically by air hoses. Through these connections any movement of the controls in the leading locomotive is instantly duplicated in the trailing locomotive, which is driverless.

As a matter of interest we reproduce herewith a graph showing the performance of the two 625 h.p. locomotives operating in multiple in the low speed and high speed ranges, with 1150 h.p. at transmission input shaft.

Lorry Crane Attachment

A NEW crane, which can be fitted to most makes of lorries, has been introduced by Lorry Loaders, Ltd., Plant House, Ealing, London, W.5, to facilitate and speed the loading and unloading of road vehicles. The crane is to be seen in operation in the photograph we reproduce below. It consists essentially of a post unit mounted on the chassis just behind the driver's cab, and is hydraulically operated, the pressure fluid being supplied at about 1000 lb per square inch by a pump driven from a power take-off from the gearbox of the vehicle. To fit the crane a space of only 9in wide is normally required between the cab and the lorry body, but this space and the method of attachment naturally vary according to the design of the vehicle. The crane complete with the pump unit weighs about 7 cwt.

These cranes are made with two capacity ratings of 1½ tons and 1 ton, and the length of the tubular jib can be adjusted. The higher-capacity crane is designed to lift from 30 cwt at 5ft 6in radius to a height of 8ft 4in above the top of the chassis frame to 10 cwt at 11ft 10in radius to a height of 11ft 4in. The smaller-capacity model lifts from 20 cwt at 5ft 6in radius to a height of 8ft 4in to 7½ cwt at 11ft 2in radius to a height of 11ft above the top of the chassis frame. The jib can be slewed through 180 deg.

The crane hoisting, slewing and lowering motions are controlled by a single lever arranged on the valve chest set at a convenient operating height on the lower part of the post. This lever can be moved along a quadrant to the appropriate gate and on then being drawn forward the required movement commences and the speed is controlled thereafter by the setting of the lever. The control lever is spring loaded to return automatically on release to the stop position, and whilst it is in a non-operative position the load setting is maintained. Load lowering is effected by gravity and the speed of movement is under full control at all times.

To relieve the vehicle chassis and springs of undue strain whilst loads are being handled a hydraulic telescopic leg fitted to the lower end of the crane post is set down, before operations begin, to give a large measure of support.

The crane post is mounted on a heavy tubular steel base, which is rigidly attached to the chassis by a bracket plate bolted to the frame side member. Further support is given by an angle iron cross frame member and a tubular strut set at an angle and bolted to the opposite frame side member. The crane support member encloses the lower part of the rotating post, which is supported on a ball thrust bearing and turns on roller bearings at the top and a plain phosphor-bronze bearing at the lower end. A hydraulic slewing unit is built into the lower end of the crane. In this unit there is a paddle or vane, which moves through 180 deg. in an annular hydraulic chamber and which is keyed to the end of the rotating crane post. Admission of pressure fluid to either side of the chamber with simultaneous release from the other side moves the vane round the housing and slews the post.

The jib, as can be seen, is pivoted at its foot to a swan-neck bracket of heavy sheet steel which projects rearwards from the head of the crane post. A piston-rod projecting upwards from the centre of the post is hinged to the jib a short distance up from its foot. This rod at its lower end registers on the piston of a hydraulic cylinder formed in the crane post. As the piston moves up or down it raises or lowers the jib through the piston. An arrangement of valves within the post prevents over-elevation of the jib and a release valve in the hydraulic system prevents overloading of the crane. A non-return valve is fitted to avoid loss of control of the crane in the event of an oil supply pipe fracturing.

The tubular steel jib is made in three sections and the intermediate and top sections can be telescoped into the foot section. The two telescoping sections can be set to give the required jib length and are locked in the required operating position by means of simple hand screw clamps. When the crane is not required its jib is fully retracted, slewed round and lowered to stow with the head resting in a support bracket behind the driver's cab.

It will be appreciated that the crane is arranged for use with set jib lengths, but means are provided for the fitting of a hoist rope attachment for special purposes.

Crane Fitted to Lorry

Newcomen Society

THE annual general meeting of the Newcomen Society for the Study of the History of Engineering and Technology was held in London on Wednesday evening of last week. The thirty-second annual report of the council, which was presented by Mr. A. S. Crosley, the honorary secretary, recorded another year of progress. The attendance at the general meetings of the Society was well maintained throughout the year. A special mention was made in the report of the increased activity of the Society's Midland branch. Reference was also made to the continued growth of the affiliated North American Society, the membership of which now exceeds 14,000. During the year, the report stated, the North American Society had celebrated the thirtieth anniversary of its foundation, a function which was attended by Mr. J. Foster Petree, president of the British Newcomen Society. At the conclusion of the formal business of the annual general meeting, Mr. Rex Wailes was inducted to the presidential chair in succession to Mr. Foster Petree, who has completed a two-year term of office. Prior to the annual general meeting, Mr. Foster Petree delivered his presidential address. It dealt mainly with visits made in recent months to the U.S.A. and included some comparison of the policies of the British and North American Newcomen Societies.

Road Traffic Census

SOME details have now been published of the results of the road traffic census, arranged by the Ministry of Transport and Civil Aviation, which took place during the seven days from Monday, August 17th, to Sunday, August 23rd. The census was taken at 100 points, mainly outside built-up areas, fifty-seven on trunk roads and forty-three on Class I roads. Every vehicle passing these census points between 6 a.m. and 10 p.m. was counted, and motor cycles, motor-cars, omnibuses, goods vehicles, horse-drawn vehicles, and pedal cycles were separately counted. For the first time, in a census of this kind, the motor cycles were divided into three sub-classes : solo, combination and motor-assisted pedal cycles. By comparison with previous censuses it is revealed that for the country as a whole there has been a 17 per cent increase in vehicles of all kinds since 1950 and a 23 per cent increase since 1938. In the various classes of mechanically propelled vehicles there has been an increase of about 20 per cent since 1950, with the exception of omnibuses, which have decreased slightly. The changes since 1938 are, however, much more varied, e.g. while there has been an increase of 88 per cent in goods vehicles, private cars have increased by only 4 per cent in the same period. Horse-drawn vehicles and pedal cycles both show a further decrease since 1950. The largest increase in mechanically propelled vehicles occurred in Wales. The goods traffic in Wales has also grown to a greater extent than in the rest of the country and is now well over double what it was in 1938. The percentage of goods traffic on the roads is now greater than before the war, amounting in fact to some 27 per cent of all mechanically propelled traffic. Over half the mechanically propelled traffic, however, is still made up of private cars. The composition of the traffic in 1953 was almost identical with that in 1950. In the motor cycle class nearly 80 per cent were solo machines, including motor-assisted pedal cycles, which were 6½ per cent of the total.

YOUNG EMPLOYEES AND FURTHER EDUCATION.—The British Association for Commercial and Industrial Education is arranging a meeting, to be held on December 4th, in the Council Chamber, Birmingham, to discuss the subject of day release of young employees for further education. The principal speakers will be Sir Arthur Fleming, of Associated Electrical Industries, Ltd., and Sir Hugh Chance, of Chance Brothers, Ltd. The Lord Mayor of Birmingham will preside.

Multiple-Unit Diesel Train in Aluminium

By E. G. WEST, Ph.D., B.Sc.

The light metal trains which have been designed and built for the Deutsches Bundesbahn, as a result of a directive by Professor E. Frohne, Director of the Deutsches Bundesbahn and Secretary of the Ministry of Transport, are not yet in service, but were exhibited at the Munich Traffic Exhibition held earlier this year. The trains described are intended to compete with inter-city aircraft services by providing a high-speed regular service with comfort of aircraft standard.

TWO multiple-unit, diesel-driven aluminium trains which have been designed and built in Germany during the last two-and-a-half years embody many interesting ideas; their construction resulted from the decision of a working party of technical representatives of the German Federal Railway system, constructional concerns and the light metal industry. They were built by the Linke-Hoffmann-Beyger Company, powered by M.A.N. diesels, and air-conditioned by J. Stone and Co., Ltd.

The two trains comprise a day and a night version of the same basic design. The day train has accommodation for 135 seated passengers and the night train accommodates forty sleeping and twelve seated passengers or a smaller number of first-class sleepers. Each train consists of five trailer coaches with a driving vehicle at each end. The lay-out of the day train is shown in the accompanying diagram. The trains are fully articulated, the principal difference between them being that the sleeping coaches are carried on two-axle bogies and the day coaches on single-axle bogies. The general design is reminiscent of the American-built "Talgo" train which has now been running in Spain for some three years.

In addition to the passenger-carrying coaches there have been included a dining-car and kitchen, a bar, luggage compartments, cloakrooms and toilets and an office compartment in which a dictation machine, &c., may be used. The train is fully air-conditioned, the necessary plant being run from an auxiliary diesel motor and electrical generator. Fluorescent lighting has been used throughout, with two different systems installed experimentally.

The leading data for the day train are given in Table I.

The day train with 135 seats gives 1·45 square metres (15·6 square feet) useful area per passenger and taking a weight of 93 tonnes, the weight is 0·962 tonne per metre length of coach. The sleeping-car train weighs 102 tonnes with forty-six sleeping passengers and provides a useful area of 4·09 square metres (44 square feet) per passenger, with a corresponding weight of 1·06 tonnes per metre length of coach.

A principal requirement for the train was that the floor should have the same height throughout the length and, furthermore, the train should present as open an appearance as possible. Another important requirement at the design stage was the selection of driving motors from normal works production, so mounted that in the event of a breakdown the faulty motor could be rapidly removed and replaced with a spare. It was also necessary to obtain the lowest possible centre of gravity to assist running on curves.

Experiments made by the Railways Experimental Office, Minden, showed that it was possible to adopt a single-axle bogie of the Kruckenberg pattern and this arrangement was used for the day train, but in order to maintain axle loads as near equal as possible two-axle bogies were provided below the engine-rooms in the leading coach. Clearly the suspension and the detailed method of articulation are all important features of light-weight trains and it appears that the problems involved have been satisfactorily solved, although to date little detailed information is available.

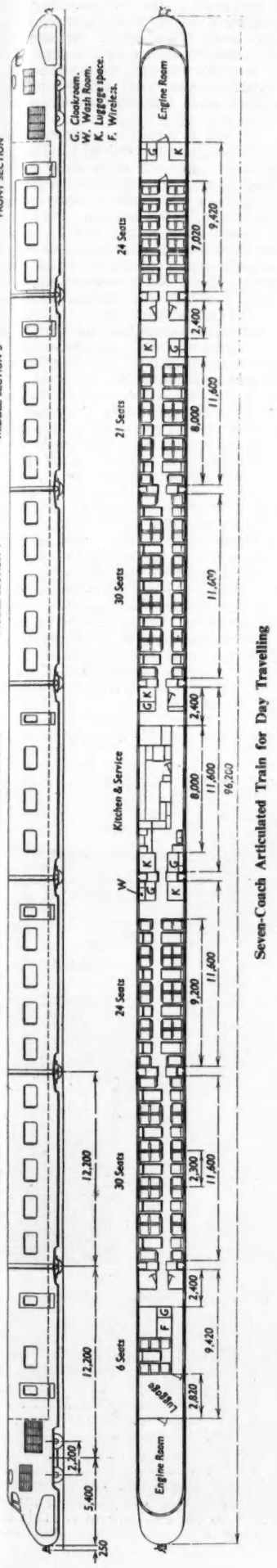
TABLE I

Length along the skin	96,200mm (316·62ft)
Maximum width	3,024mm (9·92ft)
Height above rail level	3,525mm (11·57ft)
Internal height in the passenger accommodation portion	2,250mm (7·38ft)
Track gauge	1,435mm (4·71ft)
Bogie wheelbase (below the driving compartment)	2,200mm (7·22ft)
Wheelbase below the middle cars and distance of the bogie pins from the next individual axle	12,200mm (40ft)
Floor height in the passenger-carrying portion above rail level	850mm (2·79ft)
Floor height in the passenger-carrying portion above rail level, for leading portion	1,250mm (4·10ft)
Seating places	135
Highest speed	160km/hr (100 m.p.h.)
Unladen weight	About 88 tonnes
Motive power	4–160 h.p. M.A.N. diesel engines giving a total of 640 h.p. unsupercharged
Total laden weight	Less than 100 tonnes
Minimum carriage width	3,024mm (9ft 11in)

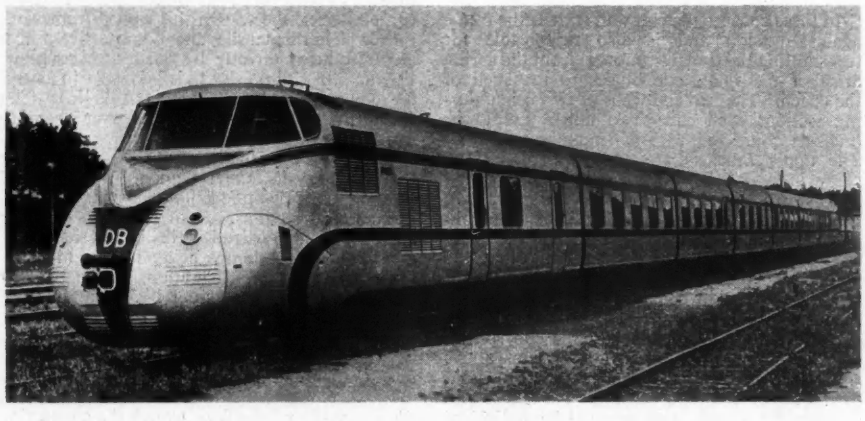
The appearance of the trains may be observed from the various illustrations.

COSTS AND MATERIALS

A note on the cost may be advantageously inserted here. The total weight of aluminium alloy per train was given as 28 tons out of the total tare weight of 88 tons. At an average cost of 5000 D.M. per ton (approximately £425) the total cost of aluminium per train is approximately 140,000 D.M. or almost £12,000. This



Seven-Coach Articulated Train for Day Travelling



Light Metal Articulated Train

was stated to constitute rather less than 9 per cent of the total cost of the train and the excess cost as compared with a steel train of the same type would amount to about 6·8 per cent. It is claimed that this is more than counteracted by the savings resulting from a reduction in weight of 25 per cent compared with the lightest steel construction.

The aluminium-base materials used for the greater portion of the construction of these trains comprised almost exclusively the Al-Mg-Si alloy which is generally similar to H10 alloy included in the British Standards, B.S.1470 and B.S.1476. It was used in the form of extruded sections, of sections formed from strip, and as sheet for internal and external walls. The door frames were of the same alloy, but window frames were of the 3 per cent magnesium aluminium alloy generally similar to N.4 or N.5 of B.S.1476. A great deal of spot welding was used in the construction of these coaches, together with a certain amount of argon arc welding.

Seating Arrangement in Large Compartment

In addition to the theoretical design work many experiments were carried out at the Technical High School, Brunswick, to confirm the calculations, particularly in regard to buckling. The experiments were undertaken on accurately scaled-down models of sections because suitable testing machines for full-scale units of structure were not available.

General Design Factors

All the members of the train were designed as aluminium alloy monocoque structures with stiffeners and stringers very similar to aircraft construction. The determining dimensions were as follows :—

Underside of coach to rail level	270mm (10⅝in)
Height of floor above rail level	850mm (2ft 9½in)
Internal height within the coach	2250mm (7ft 4½in)
Minimum height of the framework of the coaches	3255mm (10ft 8⅛in)
Width of door opening	800mm (2ft 7½in)
Height of floor of engine compartment above rail level	1250mm (4ft 1¼in)

In these coaches the end wall stiffens the frame against torsion and is also responsible for transmitting the transverse forces from the spring arms of the single-axle bogies to the shell of the coach. The two end walls of two neighbouring sections each carry two upper and lower brackets connected with a pendulum-type link. The upper brackets are so formed that they carry in addition the bearings for the spring arms which bear on the single axle bogie. Two neighbouring carriage member ends are connected with one another through two prestressed coil springs in such a way that the whole articulated train tends, on straight stretches of line, to behave like a solid structure. Only when going round a curve when the rails overcome the initial loading of the coil springs does the train pivot at the articulations above the single-axle coupling points. Solid, non-elastic centre couplings transmit the tensile and compressive forces, and prevent the individual members twisting with respect to one another around the longitudinal axis, and thus displacing the cross-section ; however, the requisite angular movements when turning corners or ascending inclines can be executed without difficulty. These angular movements in the horizontal plane are controlled by two pairs of links on each axle, which are connected to the nearest floor rib ; this control is exercised in such a way that the axle always lies on the bisector of the angle between the centre lines of neighbouring cars. An elastic coupling between carriage frame and bogie, which allows a sufficient lateral movement of both parts with respect to one another, is made of rubber elements.

General Construction

The external skin of the side walls is 1·8mm (0·071in) thick, stiffened by means of long, continuous formed sections of 0·6mm (0·024in) sheet as well as by channel section extrusions. The individual parts are assembled by spot welding. The spot welds are pitched at about 1½in centres and about $\frac{3}{16}$in in diameter. Top-hat sections are spot welded at 1½in-1½in centres, the weld diameters varying from ⅛in-¼in approximately. The "Z" sections of the side panel are spot welded at about the same intervals.

The side walls in the upper region are flat in order that the windows may fit into them, but they are cambered from the waist rail to the floor. This gives greater security against individual panels buckling, a better method of assembly and a more pleasing appearance. The window frames are of "T"-shaped extrusions and are anodised. They are bedded into the load-carrying portions of the side wall so that they will take up the high boundary stresses of the sheet where the window section is cut out. The exposed edges of the sheet have a radius of 150mm (5·9in) at the window corners to give favourable distribution of stress.

The door frames are argon-arc welded, the joints being located at the line of least stress. The door pillars are 150mm (5·9in) wide, the hinge pillar being of built-up pressings, whilst the lock pillar is a fully heat treated extrusion into which rubber packing is fitted.

The portion of the coach below the floor is riveted with solid rivets. It is a very strong compression and torsion resistant frame consisting of floor ribs riveted at intervals of 600mm (1ft 11⅝in) to two continuous container tubes, of 180mm (7in) internal diameter produced as hollow extrusions. The ribs are further stiffened with flanges, spot welded on, and they are equipped with manholes, the edges of which are turned over and made from 1·7mm (0·56in) thick sheet. On this ribbed framework into which the tensile and compressive forces are introduced directly by the centre coupling, 1·8mm (0·070in) sheet is riveted in strips 650mm (2ft 1⅝in) to 900mm (2ft 11½in) wide ; 1mm (0·039in) thick sheets lie over them to form the upper closure of the floor trough.

The roof is built in sections in a similar manner to the side walls, the 1·8mm (0·07in) external skin sheets being stiffened with 0·6mm (0·02in) formed strip sections. Roof hoops spring from 50mm (2in) high extruded ribs in the side walls, the height of the hoops being 110mm (4·33in), (arrived at from considerations of the bending moment from the centrifugal force and lateral wind pressure). They are 2mm (0·079in) thick, and are pressed from Al-Mg-Si alloy (H10). The longitudinal roof sheets are spot welded to one another and then riveted to the roof sticks.

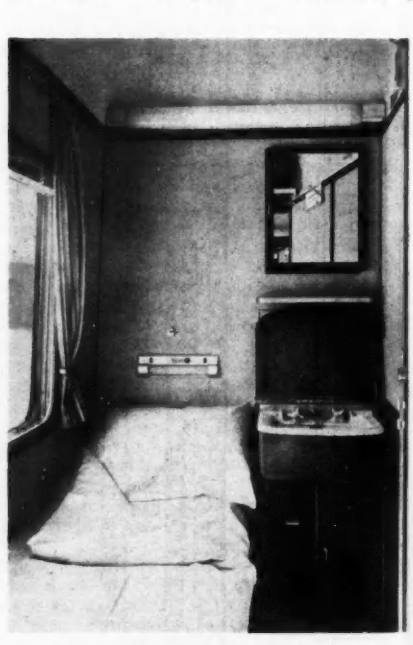
Between the roof and side wall and between the side wall and the floor trough the connection is made by means of extruded "H" stringers running the length of the carriage. The upper stringer is part of the roof while the lower stringer forms the lower boundary of the side wall. To avoid damaging the upper free edge of the sheet at the side wall and the bottom trough before assembly, an extruded section is provided at these points as an assembly aid and a striking block.

The end wall is formed as a double-walled riveted section 100mm (3·94in) thick. The 2mm (0·079in) thick external sheet was stiffened with top-hat sections and connected to the 2mm (0·079in) interior sheets by channel formed sections, or by high-grade castings. The internal form of the end wall, i.e. the transition between two adjacent carriages, was determined by the desire to preserve the appearance of full width in the train. This made it necessary to restrict the end wall to the dimensions required for the installation of the spring arms.

The important connecting members were made of high-grade sand castings, many of which were very complicated, riveted or screwed into the load-bearing portions of the coach.

While in the middle portions of the train occupied by passengers only uniformly distributed loads have in general been allowed for, the driving sections containing the engines, air-conditioning plant and other equipment, experience high local static and dynamic loads. These loads, coupled with the installation of the air-conditioning plant ventilators, &c., make shell construction in this region impossible.

From the driving bogie all forces are transmitted through one guide journal and two lateral roller supports to the main cross bearer of the carriage. Further transmission to the shell structure is effected through a box-formed main rib as well as by box bearers, which are stiffened by sub-division into individual cells, and which constitute the boundaries of the locations at which the carriage shell has to be cut away. The complete driving mechanism is suspended about its centre of gravity from a "U" jib bearer of box cross-section, which is fixed to the main rib. The load-carrying portion of this part of the carriage is completed by a longitudinal bearer passing under the floor in the engine-room, for taking up the Scharfenberg coupling. In view of the installation of the bogie the floor is 1250mm (4ft 1¼in) above rail level, and consists of a 2·5mm–4mm (0·10in-0·16in) thick heat-treated light metal projection sheet. Instead of carrying out normal electric spot welding in this region, which could only be used to a limited extent, jointing was done with the usual solid or hollow rivets, using a suitable tool. The closure of the shell construction to the engine-room is made by a double separating wall of light alloy sheets



Second-Class Sleeping Compartment

and sections. This serves at the same time to carry the heat and sound insulation of the passenger sections. In order to ensure transmission of the high loads, brought to this point by the individual box-bearers, to the rest of the shell, the latter is strengthened for a distance of 3m (9ft 9in) from the separating wall by a light metal inner shell with corresponding stiffening.

The cladding of the engine-room and the driver's position, in 2mm (0·079in) thick sheet of Al-3 per cent-Mg alloy, up to the point of junction with the main rib is not part of the load-carrying structure. Its construction is similar to that employed for omnibuses. A framework, composed of light metal angle sections supported on the longitudinal coupling carrier, is welded to the exterior cladding, in which two laterally removable flaps are provided, 2500mm (8ft 2½in) by 1200mm (3ft 11in) for dismantling the engines, along with break-through points for installation of the Scharfenberg coupling and the ventilator. The form of this nose end is decided not only by the technical requirements for installing the engine, &c., but also by aerodynamic considerations. This portion of the train is so formed that it can travel in both directions with the least possible air resistance.

These trains, although they have not yet operated in actual service, have given a clear indication of the type of railway vehicle which is receiving urgent attention on the Continent and also in the U.S.A. The savings in fuel which result from the lower weight, coupled with the higher accelerations possible, constitute important advantages which cannot be overlooked in considering future competition between rail travel and road and air travel. This latest development should, without doubt, provide invaluable information to the whole of the German railway industry and will further increase competition from Continental builders in the important field of rail vehicle exports. It is hoped that as more detailed information becomes available, including the results of trials and operation under normal service conditions, reports will be available for publication.

Triple-Screw Launch

TRIALS were completed recently of a triple-screw launch, which will be used for service on Lake Maracaibo, Venezuela, and has been built by John I. Thornycroft and Co., Ltd., for the Compania Shell de Venezuela, Ltd., which is the associated Canadian company of Shell Tankers, Ltd. The launch will be used for the transport of men, materials and equipment to the drilling rigs situated up to 24 miles off the eastern shore of Lake Maracaibo, which is a large stretch of water, some 95 miles long by 65 miles broad, and subject to sudden squalls and the full force of the prevailing wind. Arduous service requirements have to be met, since the launch must operate to a rigid schedule under any weather conditions in order to relieve the crews on the drilling rigs, which can offer no shelter to craft coming alongside. Under such conditions the service launch has to be of robust construction to withstand heavy battering and also to withstand possible underwater damage due to the presence of a large amount of driftwood in the lake.

The launch, which was built at the Woolston (Southampton) yard of the builders, has a length overall of 48ft by 15ft beam by 3ft 3in extreme depth and has a speed of 18 knots. To meet the severe service conditions the main hull is of mild steel, the bottom plating forward of amidships being ⅜in thick, while the remainder of the bottom plating and the side plating is ¼in in thickness. The superstructure is of aluminium alloy, supplied by the British Aluminium Company, Ltd., as are the bulkheads, excepting for the bottom strake of plating, and aluminium alloy chequer plating has been used for the deck plating, cabin floor and engine-room floor plates. The hull, which is partly riveted and partly welded, is of hard chine form with a raked stem, transom stern and false keel to facilitate slipping. There are four watertight bulkheads, which divide the craft into five compartments consisting of the fore peak, passenger cabin, engine-room, fuel tank space, and steering gear compartment. To give some protection to the hull when moored to the drilling rigs a " D " section steel fender is welded to the hull from stem to stern at a level midway between the deck and the water line, and there is a tubular rubber fender, of 4in outside diameter and 2in bore, fitted completely around the launch at the gunwale.

The sides of the light alloy wheel house, which is not fully enclosed, are extended aft as a coaming. Two searchlights are mounted on the roof and also two cowl ventilators, one of which is trunked to the bilge and one engine, while the other serves the remaining engines. Steering is effected by a car steering wheel ; there is a Kent clear view screen and the helmsman has the instrument panel and engine controls comfortably to hand. A light alloy ladder leads down from the wheel house to the passenger cabin, immediately forward, which is fitted with removable tubular seats sufficient to seat twenty persons. On the port side at the aft end of the cabin is a toilet compartment and ventilation is by means of four half-drop windows of ⅜in thick armoured plate glass, three opening circular scuttles, a water-excluding box ventilator, and four mushroom ventilators on the cabin roof. The roof is of canvas-covered resin-bonded plywood and has an escape hatch. A small watertight opening in the cabin forward bulkhead gives access to the fore peak. Immediately aft of the cabin is the engine-room, access to which is by ladder at the aft end of a raised casing. Further aft is the fuel tank space, which is entered through a hatch in the deck, and from this space a watertight opening gives access to the aft peak, which houses the Mathway steering gear controlling the twin rudders.

In the engine-room there are three Rolls-Royce Mark C6.SFLM six-cylinder in line, four-stroke, direct injection diesel engines, which have a bore and stroke of 5½in by 6in, and each develop about 190 b.h.p. at 1800 r.p.m. to give the launch a speed of 18 knots. The wing engines, over which are portable flush deck hatches, are mounted further aft than the centre engine, and all engines are to the same hand and are equipped with oil-operated reverse gears supplied by the Self Changing Gear Company. The engines, which are completely controlled from the wheel house, drive three-bladed manganese bronze propellers, mounted on Monel metal shafts carried in water lubricated rubber bearings fitted at the " A " brackets and stern tubes. A Stuart Turner diesel auxiliary generating and pumping set is fitted forward to starboard and consists of a 3 b.h.p. single-cylinder diesel engine driving a 1½kW, 25/35V, 60/43A battery charging dynamo and a bilge pump having a capacity of 900 gallons per hour.

Air is supplied to the engine-room by two cowl ventilators mounted on the wheel house roof and water-excluding vents in the wheel house front, while the air is exhausted by torpedo extractor vents fitted with Airmax fans. Fuel for the engines is carried in two tanks, each of 112 gallons capacity, housed in the tank compartment aft of the engine-room.

Triple-Screw Launch

Transport Costing

IN 1951 the Institute of Municipal Treasurers and Accountants and the Institute of Cost and Works Accountants formed a joint research committee to study the costing problems of local and public authorities, its first research being into the methods of controlling the costs of road transport vehicles (other than passenger transport) in local and public authorities.

The report, which the committee has now published, stated that transport was chosen as the first subject for consideration because the total expenditure by local authorities under this heading in Britain is estimated at £16,000,000 per annum, and moreover, the total national expenditure on road haulage, excluding any share of expenditure on the upkeep of roads, is estimated at some £600 million per annum.

Consequently, its investigations would be of concern also to all who run road services.

The costing of road haulage, the report noted, illustrated clearly the need for the establishment of realistic standards of comparison, for so often an imperfect standard cost led to unjustified self-satisfaction. Another point to which the report drew attention was the need to restrict the data collected to that which was actually going to be used.

It would often be found, the report continued, that about two-thirds of the total cost of motor haulage represented the wages of drivers, licences, insurance, depreciation (or capital charges), and garaging. About one-sixth covered repairs to the vehicle and renewal of parts, and the other sixth comprised fuel. These proportions were only approximate, but they were important because they indicated where

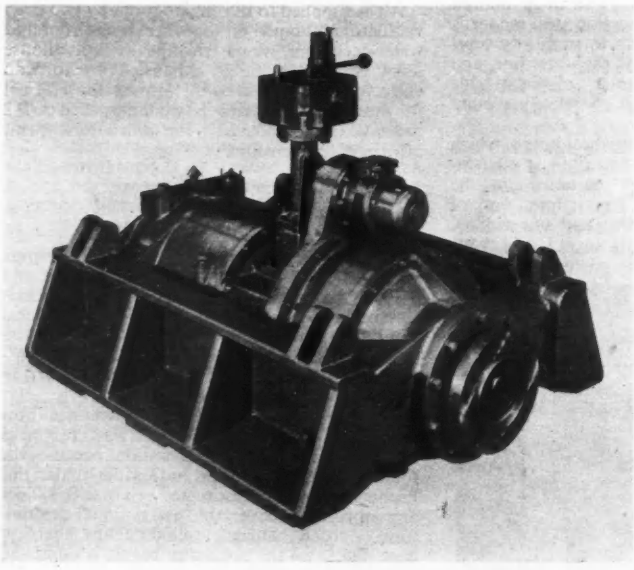
economies would most probably be obtained. It was evident that the greater part of the expenditure incurred in operating a motor vehicle arose merely from having it available for running : the amount of effective work done influenced that particular part of the total expenditure relatively little. One-sixth of the expenditure—the cost of repairs—was affected much more by the amount of running than by the mere lapse of time, while the remaining sixth—expenditure on fuel—varied almost proportionately with mileage, given similar conditions of work.

The report stated that 1 per cent better utilisation of vehicles in this country would result in reduced expenditure of £4,000,000 per annum. That view, it was stated, was in line with the conclusions reached in many of the reports on American industrial methods, issued by the British Productivity Council, namely, that the lower industrial costs of the United States are largely due to the longer production runs and therefore it was worth making an effort to use the industrial apparatus, in the widest sense, intensively.

The report did not lay down in detail the necessary procedures or documents required for running a road haulage department, but it condensed the experience of many authorities of various sizes and discussed briefly the methods which are found to be effective in keeping costs down, and brought out certain factors, often overlooked, to which attention was necessary if a transport service was to run economically.

Marine Reversing Gear

OUR photograph illustrates an addition to the range of marine gearboxes manufactured by Self Changing Gears, Ltd., which is suitable for engines developing 550 h.p. at 1000 r.p.m. This Mark MRFE 16C unit is compact and designed for heavy duty ; the oil-operated clutches give a smooth take-up of drive while either clutch is engaged by a simple movement of the selector handle. The gearbox, which has helical epicyclic gears, is available for left or right-handed rotation and has a reduction ratio ranging from 1·6 to 1 to a maximum of 3 to 1. For the ahead drive there is an oil-operated clutch with plates made of bronze and steel and lubricated by the oil used for engaging the clutch. The astern clutch has a special epicyclic gear to give smooth astern drive and the circulation of the lubricating and operating oil is by a gear pump. Side bearers of robust design and cast in aluminium alloy carry the gearbox, which is entirely independent of the engine and, due to precision location points, can be easily interchanged. The arrangement of the gear with the clutches interposed between the input and output couplings allows the couplings to be on the same shaft line. Control is exercised simply by an oil valve to divert the oil to the appropriate clutch and, as it only requires a pressure of a few pounds to move the lever, the installation of remote control is an easy matter. Maintenance of the unit is simple and consists of topping-up and changing the oil while no clutch adjustment is required since the clutches are self adjusting.



Marine Reversing Gearbox

Research Ship "Sarsia"

SUCCESSFUL trials were carried out recently in Start Bay by the diesel-driven research ship "Sarsia," which has been built by Philip and Son, Ltd., Dartmouth, to the designs of Messrs. Graham and Woolnough and to the requirements of the Marine Biological Association of the United Kingdom for comprehensive marine biological and oceanographical research. The ship has a length overall of 128ft by 28ft breadth moulded by 13ft depth moulded, a mean load draught of 9ft 6in and has a designed speed of 10 knots.

Accommodation is provided for four scientists in addition to the ship's complement numbering sixteen, and mechanical ventilation and heating systems are fitted throughout. A 20ft lifeboat and a 21ft motor lifeboat, carried under Bi-Luff davits, form the boat equipment, together with a small working dinghy, which is stowed on the fore deck. Adequate store-room space is provided ; it includes a special compartment in the forecastle for the stowage of dredges, nets and collecting baskets, while in addition to a refrigerated store for domestic use there are two cold chambers for scientific purposes.

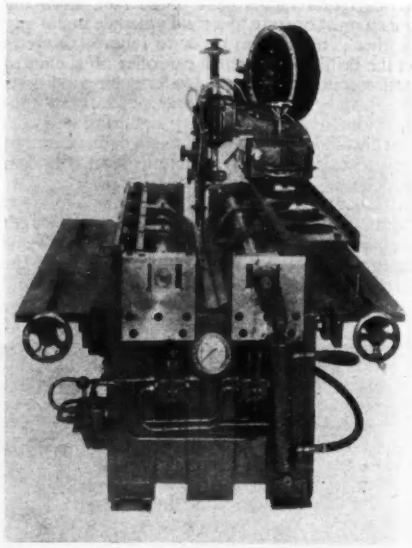
For research work the facilities include a complete set of trawling equipment, the trawls being operated by a heavy three-drum winch, of which two drums each carry 500 fathoms of 2½in wire for trawling and the third has 2000 fathoms of 1¼in wire for special deep net work. All the wires are arranged to pass over recording sheaves. Two hydrographic winches are supplied for biological and oceanographical work, the larger unit, holding 3 miles of 4mm wire, is fitted in the forecastle and functions in conjunction with a Munro accumulator and a depth recording davit, while the smaller unit, which is located at the aft end of the deck-house, holds ½ mile of 6mm wire and operates over the stern through a sliding, extending boom on the after derrick. All the winches are operated by Vickers-Armstrong V.S.G. control gear. There are two fixed tanks on the port side of the main deck and also a number of portable tanks for keeping live specimens while at sea.

At the forward end of the main deck-house is the main laboratory equipped with scientific instruments to maintain and extend the marine biological work at Plymouth and at the aft end of the house is the rough or wet laboratory. Both laboratories are provided with a variable voltage d.c. supply, from 6V to 36V, from a battery room, for special electrical experimental work. To assist in the work and to serve as an aid to navigation, the ship is fitted with Decca radar and navigator sets, Kelvin and Hughes shallow and deep sea echo-sounders and a Marconi recording echometer.

The ship is propelled by a six-cylinder, pressure charged, four-stroke diesel engine, built by the National Gas and Oil Engine Company, Ltd., capable of developing 270 s.h.p. at 450 r.p.m., and driving the propeller through an oil-operated S.L.M. gearbox, supplied by Modern Wheel Drive, Ltd., and having reverse reduction gears of 3 : 1 ratio. For fine net trawling low speed is necessary and this is achieved by the "Woolnough" arrangement of a creeping speed device, independent of the main engine, whereby a 20 h.p. variable speed electric motor drives the propeller shaft through the main gearbox and is so arranged that it can only be engaged when the main engine is disengaged from the reverse reduction gear. With this arrangement a steady speed of 1 knot was achieved on trials when trawling with a fine plankton net. There are two auxiliary generator sets, the port unit consists of a National "M.4A.6" diesel, of 165 b.h.p., driving through a Modern Wheel Drive clutch and reduction gear, a Maudsley 60kW generator, and the V.S.G. trawl winch equipment. The starboard set consists of National "M.4A.3" diesel engine, developing 60 b.h.p., driving a Maudsley 35kW generator and a Reavell air compressor through a hand clutch. The main and auxiliary engines are fresh-water-cooled and all are resiliently mounted to keep vibration to a minimum so as not to affect the delicate instruments and the research processes associated with the laboratories.

Strip Metal Clamping and Welding Machine

A MACHINE has been developed by F. Bode and Son, Ltd., Buxton Road, Leek, to facilitate the continuous cold rolling of strip metal by welding short lengths together to form a long coil. This strip clamping machine enables strip of any width to be clamped in correct alignment for butt welding by an "Argonarc" automatic head. The welding head, as can be seen in the illustration of the machine on this page, is mounted on a track situated above, and on one side of, the machine.



Strip Metal Clamping and Welding Machine

Metal strip is centralised and guided in the machine by two metal pegs projecting up through slots in the table ends at each side of the machine. These metal pegs are adjusted the required distance apart by means of a handwheel which operates through a lead screw. Clamping beams on each side of the welding position are actuated by means of hydraulic or air cylinders to hold the strip firmly in position along its entire width during the welding operation.

The machine is made in two forms. One model is designed to accommodate strip material from 9in wide up to any desired maximum specified. It can be operated from a main air or hydraulic supply or fitted with a self-contained pump and motor unit. A small machine which can be operated by mechanical means is suitable for use with strip from 4in to 18in wide.

Mine Wagon Drill

WHEN a Swedish mining company, Luossavaara-Kiirunavaara A.B., decided a short while ago to start large-scale underground exploitation, sub-level caving was selected as the most suitable method. For this work there was required a quick and efficient method of drilling holes in a fan-shaped arrangement in the workings. An inquiry for a suitable drilling machine was placed by the company with the Atlas Diesel Company, of Stockholm, Sweden, and that firm developed the new wagon drill shown in the accompanying illustration. The new drilling equipment has been in service for some little time in the mine, and we are informed that it has reduced the cost of rock drilling considerably and has simplified the selective mining of large ore bodies.

At the Kiruna mine the new machine is used for ring drilling in drifts 10ft high and 15ft wide, and in each ring sixteen holes are drilled to a maximum depth of 20ft. The rings of holes are spaced between 3ft and 4ft apart and when drilling the top holes the feeding device is inclined some 70 deg. to the horizontal.

The wagon has a compact operating panel, from which the movements of both the rock drills and the feeding device can be controlled by a single operator. By means of grouped selector levers on the panel the operator is able to position the drills and drill all the holes in a ring quickly and without undue movement or effort, whilst all the operations are in clear view. It is stated that the machine is capable of drilling some 500ft of holes in an eight-hour shift.

In order to avoid the use of expensive and awkward air lines to feed the machine, the compressed air for its operation is supplied by an electrically driven compressor mounted on a chassis fitted with pneumatic-tyred wheels. This method has been found advantageous, in that the heat of the compressed air eliminates the mist in the air exhausted from the rock drills. This does much to improve working conditions in workings where low temperatures prevail.

Mine Wagon Drill

The drilling rig is mounted on a carriage with four pneumatic wheels, the two smaller ones at the rear being used for steering purposes when moving from point to point. To provide rigid support for the machine during the actual drilling operations screw jacks on each side of the carriage are lowered to remove the weight from the pneumatic wheels. The carriage has mounted on it a heavy cast iron frame with an integral gear housing. Two longitudinal shafts extend forwards from the gear housing and on the cross members of these shafts there are mounted two pivoted feed units. Each of these feed units consists of two feed beams, along which a chain-driven slide carrying a rock drill moves. The chain feeds are driven by air motors arranged underneath the beams and they give a feed length of just under 8ft. The feed units can be moved through an arc of just over 180 deg. and tilted about 30 deg. forwards from the vertical position. For traversing these units two air motors are provided and their drive is transmitted to the longitudinal shafts through a gear wheel.

Whilst drilling is in progress the feed units are locked in position by a compressed air brake, which operates two brake drums mounted on the longitudinal shafts. This brake is released automatically when the feed units are swung round to fresh drilling positions. On the upper ends of the feed units are sliding dowels, which serve to support the beams during working, and on each dowel there is provided a support for the drill steel. Both the dowels and the drill steel supports are actuated by compressed air cylinders.

Travelling Tower Crane

A NUMBER of improvements have now been incorporated in the travelling tower crane made by R. H. Neal and Co., Ltd., Plant House, Ealing, London, W.5, which was described in our issue of November 14, 1952. This crane consists essentially of a self-erecting 80ft. steel tower, with two 20ft. removable intermediate sections, and a horizontal boom giving a maximum lifting height of 66ft. It has a power-operated hoist trolley, which runs along the underside of the boom and enables the load to be lifted or lowered at any required point within a maximum radius of 53ft.

With the new arrangement of the crane, if it is required to lift loads to greater heights than 66ft, the horizontal boom can be raised to one of three alternative fixed positions. These boom settings give maximum lift heights of 106ft, 113ft and 115ft respectively. With the boom in these alternative positions the trolley is left at the lower end and the hoist ropes are reeved through a pulley at the boom head. At the 106ft boom setting a load of ¾ ton can be raised at 43ft radius; at the 113ft setting 1½ tons can be raised at 24ft radius, and at the 115ft setting 2½ tons can be raised at 16ft radius.

All four motions of the crane are now operated by separate push button controlled electric motors from the driver's cabin in the tower, or from a duplicate control panel on a footplate on the undercarriage.

THE INTERNATIONAL MOTOR SHOW ARTICLE.—In our account of the International Motor Show in the issue of October 30th, we wrongly referred to the Pressed Steel Company, Ltd., as having been acquired by the British Motor Corporation. It is, of course, the Fisher and Ludlow Company which was involved in that amalgamation.

Performance of the "Viscount" Airliner

IT is announced by Vickers-Armstrongs, Ltd., that the performance of the "Viscount" airliner will be considerably improved by recent modifications to the Rolls-Royce "Dart" turbo-propeller engines with which it is fitted. These modified "Dart" engines will each develop a further 80 h.p. to 90 h.p. under cruising conditions of altitude with a notable reduction in specific fuel consumption, as shown in the graph above. It will be seen also that the cruising speed of the "Viscount" is increased over its range by an average of about 18 m.p.h. The influence of this additional power on payload and range is illustrated on the other graph reproduced herewith. The static rating of this improved engine has been raised from 1400 s.h.p. to 1550 s.h.p.. When first fitted to the "Viscount" in 1948 the "Dart" engine was rated at 1000 s.h.p.

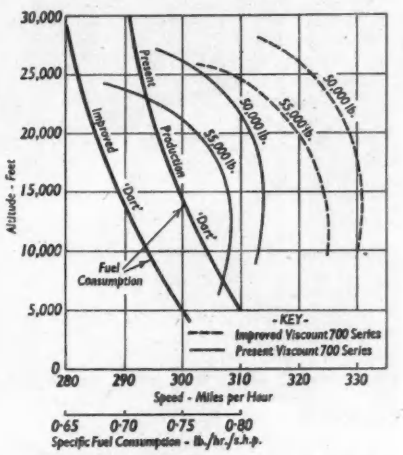
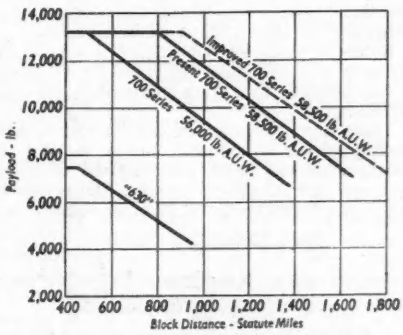


Fig. 1—Engine and Aircraft Performance Characteristics



With allowances and reserves for 230 miles diversion to alternate and 45 minutes stacking at 5000ft.

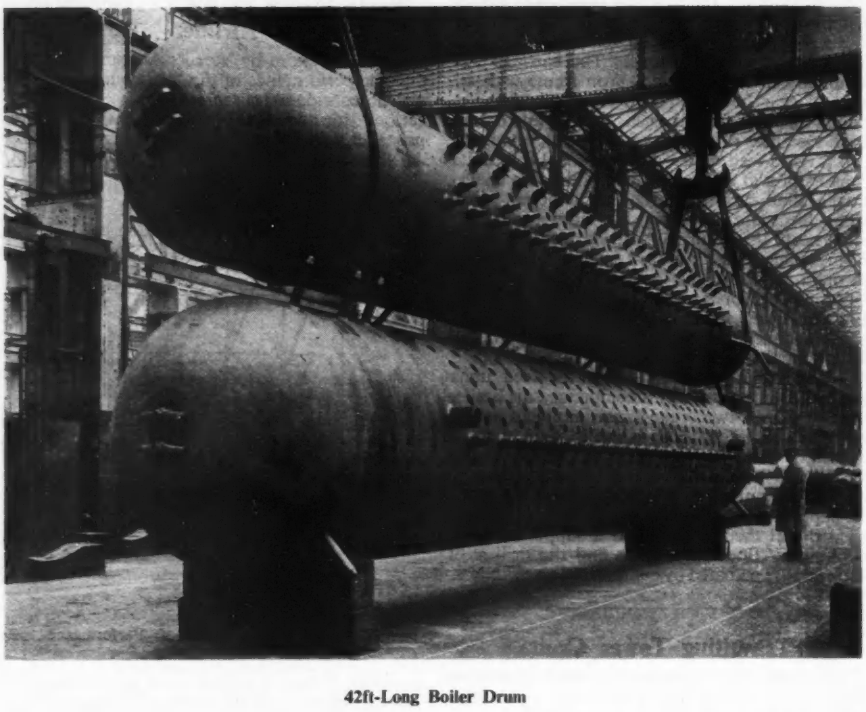
Fig. 2—Payload and Block Distance

Large Forged Steel Boiler Drum

WHAT is claimed to be the largest forged steel boiler drum ever made in one piece has been manufactured in Sheffield at the River Don Works of the English Steel Corporation, Ltd. This drum, with a length of 42ft, an outside diameter of 6ft 2¼in, and an internal diameter of 5ft 6in, is said to have the greatest capacity of any hollow forging ever produced without welding.

The drum, which has been tested to withstand a pressure of 1740 lb per square inch, will have a working pressure of 1160 lb per square inch. It has a wall thickness of 4⅛in, which increases to over 7in at the ends. When ready for despatch, with all the tube holes drilled and the thirty-three nozzles fitted, the drum weighed some 63 tons.

To make the forging, a 153-ton billet was produced from a 217-ton ingot made from three large furnaces in the firm's Siemens acid open-hearth plant. It was forged into shape under a 7000-ton electro-hydraulic forging press, operat-



42ft-Long Boiler Drum

ing at a pressure of 2½ tons per square inch.

The forging was machined in the central shops at River Don Works, where the equipment includes a 72in lathe, capable of taking drums up to 60ft in length, and a double-ended boring machine, 190ft long, which can bore simultaneously two drums up to 7ft in diameter.

Recently, a similar, but smaller, drum, 5ft in diameter and 42ft long, was made for the same power station. This drum contained eighty-one nozzles.

These two drums, which can be seen in the photograph we reproduce, comprise the first of four similar sets being made by the firm for two new B.E.A. power stations, Stella North and Stella South, on the banks of the River Tyne.

American Engineering News

(By Our American Correspondent)

A Road-Roughness Recorder

An interesting road-roughness recording unit is at present being used by the Missouri State Highway Department in checking certain test sections of the state highways, aiming at the development of acceptable roughness standards. These test sections, which are scattered over the state, are being checked for progressive and comparative roughness resulting from age and traffic conditions. Other new and old highways and roads under construction are also being checked for purposes of comparison within an extensive study of pavement life.

The road-roughness recorder used by the State of Missouri is the latest of road-surface measuring machines which is based on the first such machine built more than ten years ago at the Iowa State College. The present machine is one of only six in the country. It is said to provide readings of great precision and has no variation factor to speak of. In the past, machines of this kind were largely used only to indicate a need for reconstruction or corrective treatment, but with the elimination of the variation factor the readings may be used also as acceptable standards applicable to new construction. Some time ago the State of Minnesota used a similar machine to determine acceptability by checking highways during and after construction. This state also has the highest minimum requirements for highway surfaces which are required to show less than 75in of roughness per mile. Above 100in is regarded as poor and between 75in and 100in is considered only fair. In general a roughness rate of 400in per mile is regarded as "very rough," 200in as "rough," 100in as "poor," and below 100in as "passable." Some highways in California have been constructed with a roughness factor as low as 40in per mile. These were Portland cement concrete roads with surfaces finished by a succession of smoothing and planing operations in which as many as eight passes were made.

The Missouri machine produces two records on the paper ribbon of an oscillograph. The top line indicates the up-and-down movement of the test wheel while the lower pen plots a cumulative graph of each 250ft of pavement. Essentially the machine consists of a standard tyre buffed to perfect roundness and mounted on an automobile wheel centred in a 26½in by 96in steel frame trailer. The up-and-down movements of this wheel are converted into electrical impulses and are transmitted to the oscillograph which is mounted inside the van towing the recording unit. The recorder is towed at the rate of 20 m.p.h. when making test runs.

A Large Universal Testing Machine

An order for what is believed to be the largest universal testing machine ever built has been placed with the Baldwin-Lima-Hamilton Corporation, of Philadelphia, by Lehigh University of Bethlehem, Pennsylvania. The machine is expected to be available for delivery early in 1955 and will be installed in the new Fritz Engineering Laboratory of the university. Although the machine will be the third universal hydraulic testing machine of 5,000,000 lb capacity built by the Baldwin firm, its height of 57ft is 8ft more than the next largest machine of this capacity, situated at the Denver laboratory of the U.S. Bureau of Reclamation, and 10ft more than the first machine of this capacity, which was supplied to the U.S. Naval Air Material Centre at Philadelphia in 1948. The increased height will facilitate tests of specimens at least 25 per cent and 33 per cent greater in vertical height, respectively, than is possible in the two previously built machines. The clear space in the machine for tests in either tension or compression is 40ft vertically and 10ft between columns. Structural provisions for transverse testing are to be built into and under the floor of the laboratory, to enable the testing of structures up to 40ft in length through the opening of the machine. The machine has been designed so that testing loads can be applied with a stroke up to 36in at a rate of 3in per minute by a 54in diameter hydraulic cylinder, and the loads will be measured by a separate hydraulic system employing the Tate-Emery hydraulic capsule and indicator. The machine will have the following ranges, each to be indicated by 1000 scale-divisions on two 24in diameter dials: 0–20,000, 0–50,000, 0–200,000, 0–500,000, 0–2,000,000, and 0–5,000,000 lb.

Plastic-Coated Steel and Aluminium Sheet

The Naugatuck Chemical Division of the United States Rubber Company, of Naugatuck, Connecticut, has announced the development of a process of bonding vinyl plastic films to steel and aluminium sheets, and at present a number of American manufacturers of containers, office machinery and furniture and other metal products are conducting tests with the new composite material. The resulting laminate is said to have a higher abrasion resistance than varnish, paint and baked enamel finishes. In addition, the bond of the plastic to the metal is so strong that 180 deg. bends and deep draws can be made without separating the vinyl from the metal. Two deep-drawn samples of the laminate are shown in the accompanying illustration. The cost of the laminate is higher than galvanised steel sheet, but is only about one-third the cost of stainless steel sheet of comparable gauge. The laminate is made by rolling rigid or semi-rigid vinyl plastic sheet on to heated adhesive-coated metal sheets or strip. The rolling pressure is not high. After rolling, adhesion is effected in seconds under heat lamps or another suitable heat source. The proper functioning of the process depends on the use of a special adhesive, and the correct preparation of the metal and the vinyl plastic compound. It has been found that the process can easily be adapted to high-speed production for fabricating either continuous rolls or individual panels. Up to the present, cold-rolled low-carbon steel, hot-rolled and pickled low-carbon steel and aluminium have been used to make the laminate. The metal sheets have ranged in thickness from 18 S.W.G. to 34 S.W.G. and the vinyl films used have ranged from 0·002in to 0·020in in thickness. Tests which have been conducted on the finished laminate indicate an adhesion in excess of 40 lb per square inch. This high adhesion permits the laminate to be fabricated with regular metal-forming equipment without damage to the coating. It has been established that the material can be sheared, bent, drilled, or punched without chipping. There are no special fabrication techniques required and the only limitation in fabrication is that soldering, welding or brazing cannot be used without removing the coating for a short distance on either side of the seam. In a comprehensive series of corrosion and weathering tests, laminated panels have withstood severe conditions without breakdown.

Deep-Drawn Components of Plastic-coated Steel

Industrial and Labour Notes

Engineering Wages

On Thursday of last week the executive of the Confederation of Shipbuilding and Engineering Unions again discussed the rejection by the Engineering and Allied Employers National Federation of the recent claim for a 15 per cent wage increase. A similar claim, submitted by the Confederation on behalf of shipbuilding workers, has been rejected by the Shipbuilding Employers Federation. After the meeting of the Confederation's executive, however, it was stated that no recommendation would be made to the conference of delegates of the thirty-nine affiliated unions which was arranged to take place yesterday (Thursday).

Last Monday, the national committee of the Amalgamated Engineering Union discussed the matter at a special meeting. It may be recalled that the A.E.U. national committee, at its annual conference in June, urged that a claim for a 15 per cent increase in wages should be formulated. The A.E.U. is the largest of the thirty-nine unions represented by the Confederation of Shipbuilding and Engineering Unions. Following the national committee's discussion on Monday, it was decided to recommend to the Confederation's delegate conference that there should be a twenty-four-hour token strike to emphasise the wage claim.

Overseas Trade

Provisional figures concerning trade in October, which have been given by the Board of Trade, show that the value of exports of United Kingdom goods amounted to £227,700,000, which was £16,000,000 above the monthly average for the third quarter. The figure was the highest for any month this year, apart from July, which, like October, had twenty-seven working days. Imports in October were valued at £279,900,000, which was slightly above the monthly rate in the third quarter, and which figure included £5,000,000 for aircraft and parts received as a gift from Canada. Re-exports in October were valued at £9,300,000, so that the excess of imports over total exports was £42,900,000, compared with an average of £54,800,000 in the third quarter.

The Board of Trade says that United Kingdom exports to North America in October have been valued provisionally at nearly £27,000,000, which was a little above the third quarter average. Exports to Canada were valued at £13,300,000, which was a little above the monthly average for the third quarter. Exports to the U.S.A., at £13,600,000, did not quite maintain the level reached in September, but, the Board of Trade states, they were only 2 per cent below the high average figures of the second and third quarters of this year.

Management Conference

The annual conference of the British Institute of Management was held at Harrogate last week. Most of the programme consisted of group discussions and sectional meetings, but at a final plenary session on Saturday morning, Sir Ewart Smith, a member of the British Productivity Council, spoke on the subject of "Productivity and Management." In the course of his address Sir Ewart said that there was still a long way to go in crystallising and propounding the new scientific techniques of management. It was necessary to get away from the idea that management was a subject that could just be picked up. Management, Sir Ewart continued, had a particular responsibility to make its objective clear to itself and to its workers; its aims should be greater efficiency and greater productivity. At the moment, Sir Ewart added, Britain was far too complacent and far too comfortable.

The final address at the conference was given by Sir Hugh Beaver, chairman of the British Institute of Management. In it he reviewed the proceedings of the conference and the work of the Institute. Speaking about training and education for management, Sir Hugh said that the whole body of management must be considered, and that it was no use to "fix the heart" on some perfect course for the select few. He thought that the greatly increased academic interest was particularly encouraging, and added that there was not a university which was not in one way or another considering or tackling the problem of management. From that, Sir Hugh continued, there might well evolve a development not so different from one of a hundred and more years ago, when, for example, the practical craftsmanship of engineering was finding itself as a profession and was making its case as a proper subject for teaching at the universities.

Institute of General Managers

An Institute of General Managers has recently been formed and is holding an inaugural dinner in London this evening. Membership is open to general managers and managing directors of every kind of enterprise, and it is claimed that the formation of the Institute completes the machinery which already exists to stimulate executive efficiency and responsibility.

The Institute defines a general manager or chief executive as being responsible for the overall leadership, planning, co-ordination and control of all the managerial functions in an enterprise, ensuring that the various functional divisions work together as an efficient unit in accordance with the policy decided by the directors or proprietors. One of the basic concerns of the Institute, it is stated, is the education and training of younger men who are making their way in industry and commerce and who are the future leaders of the country's enterprises. But the Institute recognises that no amount of training and examination success by itself can make a competent general manager, and it therefore emphasises the attributes of personality and leadership which are essential to the success and efficiency of any chief executive. The Institute says also that, as it is an organisation devoted to the interests of general managers, it is deliberately an exclusive body. In addition to the requirements of managerial experience and training, candidates for membership can only be accepted if they hold *bona-fide* general management appointments at the time of their applications.

The address of the Institute of General Managers is 86, Eccleston Square, London, S.W.1.

Incentives and Productivity

A statement by Mr. I. A. R. Stedeford, chairman of Tube Investments, Ltd., which has been circulated with the company's annual report, makes some comments on incentives and productivity. Mr. Stedeford suggests that the rising curve of home production, which lately has shown an encouraging increase, points the way to a solution of Britain's economic problems. He says that managements by and large are maintaining pressure for cost-reducing machines and methods, if only to stay in business, but he stresses that "we have far to go yet in increasing productivity and reducing costs to catch up with our most formidable competitors."

The main difficulty, Mr. Stedeford believes, is the lack of effective incentives, adding that a disquieting feature of our contemporary life is that "there are about two generations among us who have been schooled and conditioned to going without." This, Mr. Stedeford continues, is no argument for unbridled purchases on the home market, for the nation's purpose must be to produce more and sell it on the world's markets at competitive prices. But, he asks, are we not disposed to make too much of a bogey of a rise in home buying? The time when austerity could achieve a national balance is past. Mr. Stedeford goes on to point out that this country has to fight for its place in world markets and, his statement says, "it is hard to see how we can hold our own if production is kept down under restrictions." There must be incentives for achieving higher productivity and lower costs, and Mr. Stedeford asserts that one of the most effective is the chance of bettering one's standard of consumption. Recalling that steps have already been taken in the past year towards freeing the home market, Mr. Stedeford urges that, if we are to have a dynamic economy, that policy should be pursued to the utmost margin of safety, if not a shade further.

Productivity in the Heavy Chemical Industry

Earlier this year, the British Productivity Council published the report of a heavy chemicals productivity team which visited the U.S.A. in 1952. Prior to the publication of that report, the Association of British Chemical Manufacturers and the Association of Chemical and Allied Employers, in co-operation with the trade unions concerned, had set up a joint steering committee to supervise the distribution and study of the report and to ensure consideration of it with a view to the implementation of its recommendations.

As a first step a series of area meetings was held in various parts of the country. The object of these meetings was not to discuss in detail the twenty recommendations made in the productivity report, but to ensure by question and answer that the intentions of each recommendation and the reasons for it were fully understood. At each of these area meetings it was also agreed that a local committee should be formed to give whatever assistance and guidance firms might desire, and to try and ensure in every possible way that the maximum benefit was derived from the report. Six of these committees have now been set up, each of them consisting of four representatives of the management and technical side of the industry and three representatives nominated by the trade unions interested. Two members of the productivity team are attached to each committee to assist in elucidating any points which need clarification.

Engineering Planning, Estimating and Costing

The Department of Technology of the City and Guilds of London Institute has in the past offered an examination for mechanical engineers' estimates and specifications. Recently, however, the advisory committee of the City and Guilds has made recommendations for the revision of the appropriate course of instruction and for examinations under the title "Engineering Planning, Estimating and Costing."

It is now intended to provide a course of training in planning and estimating, costing, works organisation, and in the presentation of information in the form of reports and letters. The committee has had in mind that the new examination should be suitable for students who have already reached a standard indicated by the City and Guilds final, or full technological certificate in an engineering or related subject, and who now wish to study works organisation, costing and planning with a view to qualifying themselves for positions of greater responsibility.

A pamphlet has been prepared giving details of the new course and examination which is to be offered for the first time next year. This pamphlet can be obtained from the City and Guilds of London Institute, 31, Brechin Place, South Kensington, London, S.W.7.

Shipbuilding Employers' Federation

At the annual general meeting of the central board of the Shipbuilding Employers' Federation, held in Edinburgh on November 13th, the election of officers took place. Mr. John G. Stephen has been succeeded as president by Mr. T. Eustace Smith, managing director of Smith's Dock Company, Ltd. Mr. Charles A. Winn, who is the new senior vice-president, is joint managing director of C. H. Bailey, Ltd., and Mr. Horace Willson, the second vice-president, is chairman and managing director of William Hamilton and Co., Ltd. The third vice-president is Mr. E. J. Hunter, who is a director of Swan, Hunter and Wigham Richardson, Ltd.

Notes and Memoranda

Rail and Road

TENTH INTERNATIONAL ROAD CONGRESS.—The tenth international road congress is to be held in Istanbul in September, 1955. The Permanent Association of Road Congresses has now decided that the questions to be considered by the tenth congress will be as follows: First question—the surfacing of roads and runways and more particularly concrete roads and runways, surfacings made in the plastic binders, and questions common to various surfacings such as non-skid properties, frost and icing, and the use of mechanical equipment; Second question—soils, the bearing capacity and stabilisation of soils; Third question—low cost roads, both lightly trafficked roads in rural areas and roads in under-developed areas. Questions 1, 2 and 3 will cover the "construction and maintenance" section of the congress; the section, "Roads in Relation to Traffic," will embody the following questions: Fourth question—traffic circulation, road characteristics in relation to traffic, road equipment and accidents and safety; Fifth question—methods of financing work and the economic justification of road works; Sixth question—urban roads and traffic in cities. Further particulars may be obtained from Mr. T. Sinclair, secretary of the British Organising Committee of the Permanent Association of Road Congresses, Ministry of Transport and Civil Aviation, 21–37, Hereford Road, London, W.2.

Air and Water

PREVENTION OF COLLISIONS AT SEA.—The International Regulations for Preventing Collisions at Sea, 1948, which were approved by the 1948 International Conference on Safety of Life at Sea come into force on January 1, 1954. An order in Council has been made, to give effect to the regulations, entitled the Collision Regulations (Ships and Seaplanes on the Water) and Signals of Distress (Ships) Order, 1953 (S.I. 1953, No. 1557). The first schedule to the Order contains the Regulations, the second a list of the countries which have accepted the regulations and the third a list of the provisions revoked by the Order.

DRAINAGE AND IRRIGATION IN BRITISH GUIANA.—The Colonial Office announces that Mr. G. Lacey, adviser on Drainage and Irrigation to the Secretary of State for the Colonies, and Mr. F. A. Brown, until recently manager of the Sudan Gezira Board, have gone to British Guiana to advise its Government on drainage and irrigation and land settlement questions. Mr. Lacey will examine the technical aspects of the drainage and irrigation schemes in progress in the Colony, and further schemes for empoldering, draining and irrigating large areas of coastland. He will also advise on water control legislation, including the system of levying drainage and water rates and the organisation of the drainage and irrigation department. Mr. Brown will examine in general the problems of land settlement on the coastland of the Colony, and in particular on lands to be developed by the new drainage and irrigation schemes.

Miscellanea

MONOPOLIES COMMISSION.—The Board of Trade has announced that, on account of ill health, Sir Archibald Carter has relinquished the chairmanship of the Monopolies and Restrictive Practices Commission. Mr. D. A. S. Cairns, Q.C., has agreed to accept the chairmanship of the Commission and will take up the appointment on January 1st next.

PERNIS REFINERY.—We are informed by the Shell Petroleum Company, Ltd., that a new distillation unit, having a capacity of 3,250,000 tons a year is now on stream at the Pernis refinery, near Rotterdam, which now has an annual crude capacity of 10,000,000 tons and is the largest refinery and the most comprehensive refining complex in Europe.

KUWAIT.—We are informed that a paper on Kuwait will be presented by Mr. C. A. P. Southwell, C.B.E., the managing director of the Kuwait Oil Company, Ltd., before the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, on Wednesday, November 25th, at 2.30 p.m., and that Sir Wavell Wakefield, M.P., will preside.

TUNGSTEN PRICES.—A further reduction in the selling price of tungsten ores has been announced by the Ministry of Materials. From November 16th its selling price for tungsten ores of standard 65 per cent grade and ordinary quality has been reduced as follows: wolframite, from £12 5s. to £11 5s., and scheelite, from £11 10s. to £10 10s. per long ton unit, delivered consumers' works.

TOGGLE CLAMPS.—A series of leaflets illustrating over thirty different small toggle clamps suitable for a wide range of applications has been issued by F. Brauer, Ltd., Grove Road, Harpenden, Herts. These clamps are made for quick and easy attachment to existing equipment; they are quick and positive in action and have a high standard of finish.

PNEUMATIC TOOLS DEMONSTRATION VAN.—The Atlas Diesel Company, of Wembley, has put into service a demonstration van for visiting works where pneumatic tools such as grinders, chippers, riveters, drills, rammers, scalers, &c., are used. The van carries a full range of these tools together with specialised tools such as tappers, screwdrivers, nut runners, metal shears and portable circular saws. The tools available in the van can be tried out under factory conditions during visits and a full range of accessories is carried.

IMPROVED MAGNETIC RECORDING TAPE.—We learn that the M.S.S. Recording Company, Ltd., 21, Bloomsbury Street, London, W.C.1, is producing a magnetic recording tape (type "A.M.15") of smooth finish and medium coercivity, particularly suitable for use with low-speed recording machines operating at 7½in and 3¾in per second. Development work on the new tape was started by British Insulated Callender's Cables, Ltd., and continued by the M.S.S. Recording Company, Ltd., at experimental laboratories at Hythe End, near Staines, Middx.

FENCING OF MACHINERY.—The Minister of Labour was asked in Parliament last week if he would make a statement concerning regulations under the Factories Acts in respect of the fencing of machines which were being made, repaired and adapted for sale, but were not "machinery or plant" within the meaning of the Factories Act, 1937. In his reply, the Minister said that a most careful inquiry had been made into accidents involving machinery in course of manufacture. The investigations had satisfied him that it would be quite impracticable to frame regulations in respect of the fencing of such machines.

"COPPER IN INSTRUMENTATION."—A book entitled *Copper in Instrumentation*, published by the Copper Development Association, deals with the uses of copper and its alloys in certain classes of measuring and control instruments. The instruments are considered under three main headings: pressure and strain-responsive instruments; electromagnetic instruments; and temperature-responsive instruments. Sections are devoted to the application of copper alloys to diaphragms, capsules, bellows, Bourdon tubes, strain gauges, coils, shunts, &c. The book includes an extensive bibliography. Copies of the book are obtainable free of charge on application to the Association at Kendalls Hall, Radlett, Herts.

SUPPLEMENTARY DATA ON THE NIMONIC ALLOYS.—In order to make available, as rapidly as possible, figures determined since the last edition of its data book on "The Nimonic Alloys," Henry Wiggin and Co., Ltd., has issued a supplementary leaflet containing additional and amended tables. The torsion properties of Nimonic 80A and Nimonic 90 have now been determined over the range 20–1000 deg. Cent. and more complete fatigue figures are now available. Short-time creep tests on Nimonic 95, the latest alloy in the series, are included and new tables summarise recommended heat treatments and acceptance creep tests. Copies are available from the company at Wiggin Street, Birmingham, 16.

CRUSHING AND SCREENING PLANT FOR KUWAIT.—A large crushing, screening, bin storage, stockpiling and reclaiming plant has been supplied to the Government of Kuwait by Pegson, Ltd., for the production of aggregates required for building purposes. This plant is built to crush natural desert gravel to sizes from 1¼in down to plus 50 mesh. It is designed to handle 250 tons of material an hour and is divided into two identical sections each dealing with 125 tons an hour. Finished screened materials can be drawn direct from the main bins in the plant for sale as required, but the bulk is taken by belt conveyors to four stockpiles. An underground conveyor takes the material from the stockpiles to a large concrete mixing plant.

TWENTY-MILLION-VOLT X-RAY EQUIPMENT.—A 20,000,000V Betatron X-ray equipment, made by Metropolitan-Vickers Electrical Company, Ltd., and presented by the company to the Christie Hospital and Holt Radium Institute, Manchester, has now been installed at the hospital in the new Betratron Research Building. It is the first Betratron in this country to be installed for radiotherapy. Tests have not yet been completed, but the machine is already working at 20,000,000V and giving a satisfactory X-ray yield. These X-rays are more penetrating than those produced by conventional means and they allow an intense dose to be applied to a deep-seated tumour without damage to the skin or intervening tissue of the patient, and with reduced risk of radiation sickness.

CONTROL OF STONE, SLAG AND LIME ORDERS.—The Control of Stone Slag and Lime Orders, 1941 and 1942, which enabled the Minister of Transport to control the acquisition, use and disposal of the materials scheduled in the orders, to license quarries and to obtain returns of their production, have been revoked. The purpose of the orders was to ensure that essential users—civil engineering, agriculture, the iron and steel industry—could obtain raw materials produced by the stone industry during the war. The continuing shortages which precluded the earlier repeal of the orders have now passed. The Ministry of Transport says that the collection of statistics relating to the stone industry has proved of mutual value and it is intended that these shall be continued.

WATER TANKER TRUCKS FOR B.R.—A fleet of battery-operated water tanker trucks designed and built by Steels Engineering Products, Ltd., of Sunderland, is now going into service on British Railways. The design of these units is based on the "electric eel" truck. Each truck has a four-wheeled chassis built round a fabricated frame of electrically welded pressed steel sections. The driving axle is fitted with independently motorised wheels, the motors being carried on the wheel backplates and their pinions engaging with internally toothed gear rings. The two 40V, four-pole series wound traction motors are specially designed to provide high torque/low speed characteristics. They are controlled by a direct-acting controller with cam-operated over-centre snap action contactors giving three speeds and brake in either direction. Power is supplied by a twenty-cell "Kathanode" traction battery with a capacity of 224Ah. The tank is fabricated from rolled steel plate and galvanised on the inside and it holds 275 gallons. A centrifugal pump in a separate compartment at the rear of the chassis frame is driven by a motor developing 1¾ h.p. at 1950 r.p.m. This pump delivers 27 gallons a minute against a total head of 60ft through 20ft of flexible hose fitted with a trigger controlled nozzle.

AMERICAN IRON AND STEEL INSTITUTE MEDAL.—Mr. W. C. Bell, of Stewarts and Lloyds, Ltd., has been awarded the American Iron and Steel Institute Medal for 1953 for a paper entitled "A Review of European Operating and Technical Practices," which he delivered in New York on May 27th last. This medal, which is awarded annually for a paper of special merit and importance to the American iron and steel industry, was established in 1927 to perpetuate the memory of Elbert H. Gary, the first president of the Institute, and to stimulate improvements in the American iron and steel industry. There are no restrictions regarding the nationality of the recipient, but this is the first occasion on which the medal has been given to anyone other than a citizen of the United States.

THREAD CALIPER GAUGES.—The "Newall" adjustable roller caliper gauge for the inspection of threads on male components has now been superseded by the "Newall-Tolimit" thread caliper gauge developed by Tolimit Gauges, Ltd. In this gauge anvils of cylindrical form carry a thread of the same pitch as the component to be inspected, but of opposite helix. Each anvil has three positions to which it can be indexed to present a fresh gauging face as wear takes place. The anvils are carried on pins firmly fastened at each end of the gauge frame to prevent "spring" during use. The gap of each frame is produced to accurate limits and various classes of fit are obtained by interchangeable anvil pins, one go and one no-go. If a gauge is set to a close fit and it is necessary to change it to a medium or free fit, standard pins can be supplied for the user to make the alterations by substituting the pins.

Contracts

THE Queenship Navigation Company, Ltd., has placed an order with the Goole Shipbuilding and Repairing Company, Ltd., for a motorship having a length between perpendiculars of 208ft by 35ft 6in beam by 15ft 6in moulded depth to carry 1480 tons deadweight. A British Polar diesel engine of 1120 b.h.p. at 250 r.p.m. will be fitted, giving the ship a speed of 11 knots.

Personal and Business

MR. MARK R. REEVE has been appointed a director of Stenners of Tiverton, Ltd., Lowman Works, Tiverton

THE B.S.A. TOOLS group of companies announces the appointment of Mr. N. Blakstad as representative in Europe.

SHEEPBRIDGE ENGINEERING, Ltd., Chesterfield, announces the appointment of Mr. R. Gore as methods engineer.

CLARKSON (ENGINEERS), Ltd., Nuneaton, has opened a new office and stock-room at 98, Oxford Road, Manchester, 13 (telephone, Ardwick 4804).

MR. JAMES BLACK has retired from the technical staff of the North British Locomotive Company, Ltd., Glasgow, after fifty-nine years in the firm's service.

SMITH'S DELIVERY VEHICLES, Ltd., is the new title of the firm formerly known as Smith's Electric Vehicles, Ltd. Its headquarters remain unchanged at Team Valley, Gateshead.

MR. H. MCNEIL has been appointed deputy managing director, and Mr. J. Stewart Robinson, general manager, of Babcock and Wilcox, Ltd., Babcock House, Farringdon Street, E.C.4.

MR. E. R. JONES, director and secretary of Ruston and Hornsby, Ltd., and a director of Ruston-Bucyrus, Ltd., has been appointed to the board of Davey, Paxman and Co., Ltd., Colchester.

THE EDISON SWAN ELECTRIC COMPANY, Ltd., 155, Charing Cross Road, London, W.C.2, announces the appointment of Mr. W. L. Beeby, M.I.Mech.E., as director in charge of manufacture.

BURTON GRIFFITHS AND CO., Ltd., states that its sales organisation dealing with B.S.A. broaches has been transferred to Studley Road, Redditch (telephone, Redditch 1291). Mr. J. R. P. Davies has been appointed sales manager of the broach division.

THE LONDON MIDLAND REGION OF BRITISH RAILWAYS announces the retirement of Mr. O. E. Kinsman, divisional motive power superintendent (Midland division). Mr. Kinsman began his railway career as an apprentice at the Crewe works of the former L.N.W.R. in 1905.

CARGO FLEET IRON COMPANY, Ltd., and the South Bank Chemical Company, Ltd., state that they are now trading under the name of the parent company, The South Durham Steel and Iron Company, Ltd. The London address is Shell-Mex House, Strand, W.C.2.

THE TUBELA ENGINEERING COMPANY, Ltd., Furze Street, London, E.3, announces the appointment of sole distributing agents as follows: Canada, F. J. Edwards (Canada), Ltd., 16, Watson's Drive, P.O. Box 72, Toronto, 18; Latin America, Rabone, Petersen and Co., Ltd., 4, Exeter Street, Holloway Head, Birmingham, 1.

British Patent Specifications

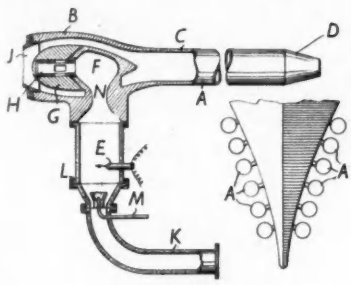
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application: the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

MARINE ENGINEERING

698,588. October 16, 1951.—THE IMPULSE DRIVING OF SHIPS, Engineering Corporation, Ltd., 56, Boulevard Antée, International Zone of Tangier.

In the drawing is shown one form of construction of the invention and an arrangement of ejection pipes on the hull of a ship. The ejection pipe *A* has three parts, namely, a head *B*, to which is connected the actual pipe *C*, which is provided with a constricted conically shaped outlet end *D*. The combustion chamber *E* extends with its part *F* into the head and is there closed by a valve *G* sliding on a tubular guide provided with openings *H* which can be closed and opened by the valve. The head and the valve are so shaped that when the gas outlet ports *H* are exposed by the valve, the valve body closes the water inlet port *J*. The combustion chamber is connected to a compressed air pipe *K*. An injection nozzle *L*,



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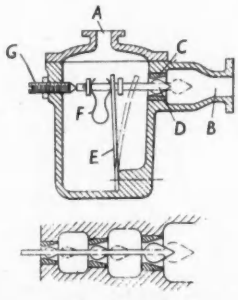
for the fuel, surrounded by a conical casing, is arranged centrally in the pipe *K*. The injection nozzle is connected to a fuel supply pipe *M* by which fuel is supplied and injected intermittently. An ignition device in the chamber operates continuously or intermittently. Between the parts *E* and *F* of the combustion chamber is provided a constriction *N*, by which complete combustion is obtained. The gases produced in the combustion chamber *E* pass into the part *F* of the chamber, and lift the valve *G* from its seat so that it closes the water inlet port *J* of the pipe and exposes the ports *H*. Through these ports the gases pass into the water pipe *C* and push the water column contained therein in the direction of the outlet end *D*. The conical constriction of this end causes the expulsion velocity at this end to be high relatively to the water velocity in the ejection pipe. Practice has shown that the pipes *A* should be arranged in rows on opposite sides of the hull of a ship in order to reduce as much as possible the front resistance of the entire installation. An arrangement of this character is shown in the drawing.—*October* 21, 1953.

VALVES

698,842. September 10, 1951.—STEAM TRAPS, Gustav Friedrich Gerdts, 130, Hemmstrasse, Bremen, Germany.

Referring to the upper drawing, the steam trap comprises a casing with inlet *A* and outlet connection *B*. In passing from the casing to the outlet connection the water flows through a single orifice in the form of a nozzle bush *C*. A flow-control member is provided in the form of a throttling pin *D* which is moved axially in the bush by a bi-metal strip *E*.



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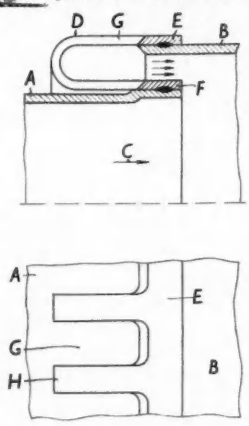
Motion is transmitted from the bi-metal strip through a leaf spring *F* to the throttling pin *D*, and the movement of the latter in its closing direction is limited by an adjustable abutment in the form of a set-screw *G*. In the drawing the throttling pin is drawn in full lines in its closed position, and it can be seen that the relative dimensions of the nozzle and the throttling pin are such that there is an annular zone in the nozzle which is permanently open. This zone constitutes the small passage through which can pass the relatively small amount of condensate arising when the plant is operating normally. When however, an unusually large amount of condensate enters the trap and the temperature of the strip changes, the throttling pin is moved out to its open position, indicated in chain-dotted lines, and thus an inner annular zone in the nozzle is opened, to give a large passage through which the larger quantity of condensate can escape. Instead of a single-stage nozzle as shown there may be provided a multi-stage nozzle in which each stage has a larger minimum cross-section than the previous stage, with a view to reducing the erosion caused by the stream or jet. This is shown in the lower view.—*October* 21, 1953.

TUBE AND PIPE CONNECTIONS

698,539. June 3, 1952.—AN EXPANSIBLE CONNECTING ELEMENT, Svenska Turbinfabriks Aktiebolaget Ljungström, of Finspong, Sweden.

In the drawing *A* and *B* are two cylindrical tubes through which a burning gas flows in the direction of the arrow *C*. The tubes, which are of different diameters, are connected together by means of an annular element *D*, the axial section of which is in the form of the letter "U." The side members *E* and *F* are welded to the tubes *B* and *A*, respectively. As the lower drawing clearly indicates, radial slots *G* are formed in the annular part *D* at some distance from each other. By this means ports are obtained for the entrance of cooling air which is adapted to pass along the inside of the tube *B*. The portions of the connecting member



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D remaining between the slots *G* are of a substantially rectangular shape, as indicated at *H*, their axial length being such as to allow them to act as springs capable of eliminating radial displacements owing to differences of temperature. In operation, the tube *A* will get hotter than the tube *B* giving rise to different expansions which should be neutralised by the element *D*. By a suitable choice of the axial length of the annular element and the thickness of the material used, the stresses caused by deformation may be kept at such a low value as to avoid any risk of fatigue breaks owing to the repeated variations of load appearing in a combustion chamber. The annular element *D* is so designed as to secure a proper flow of the cooling air, which enters through the slots *G* and traverses the space between the outer tube *B* and the inner side member of the element *D* as a uniform stream parallel with the tube, thus effectively cooling the tube.—*October* 14, 1953.

METALLURGY

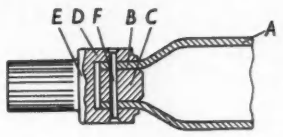
698,847. November 9, 1951.—A NEW STEEL-MAKING PROCESS, George Umpleby Noden, "Lynton," Lyndhurst Road, Brighouse.

The invention relates to a new steel-making process for the production of all types of austenitic, martensitic and ferritic stainless steels and other chrome bearing steels by the method of direct ore reduction, and particularly of stainless steels. The process according to the invention consists in charging direct into the furnace and fusing a mixture of chrome ore, scrap metal, one or more carbonaceous agents and a slag-making material, superheating the fused mixture by injection of oxygen to achieve complete reduction of the chrome ore, removing the completely reduced slag, proceeding with the heat by the oxygen injection method to remove carbon and subsequently reducing the chromium oxide in the normal way using non-carbonaceous agents. It is a two-step process carried out in a single furnace whilst maintaining the high temperature to which the original charge is raised. The injection of oxygen acts to superheat the fused mixture, to accelerate the subsequent reduction of the oxides from the slag and to eliminate impurities from the steel. The scrap metal used in the charge may be chromium-bearing steel scrap containing any percentage of chrome, ordinary plain carbon scrap free from chromium, or non-ferrous scrap containing nickel and chromium in any proportion amounting to a total of 100 per cent or a combination of two or more of these kinds of scrap. The oxygen injected during the process is preferably commercial pure oxygen or any gas containing a minimum oxygen content of 30 per cent. The carbonaceous agents used in the original charge may be either anthracite, graphite, coke or any combination of these, or any other suitable materials. A typical example of a charge and the temperatures in the furnace is given in the specification.—*October* 21, 1953.

AUTOMOBILE ENGINEERING

698,902. March 12, 1951.—PROPELLER SHAFTS FOR MOTOR VEHICLES, Daimler-Benz Aktiengesellschaft, Stuttgart-Unterturkheim, Germany.

According to the invention, the shaft is made from light metal and for securing a coupling at one or each of its ends it has a separate connection piece. With such a shaft, it is possible so to adjust the critical revolution speed that it lies outside the operating speed range of the shaft. The drawing shows part of a propeller shaft for a vehicle with a rear-axle drive. The shaft *A* consists of a light-



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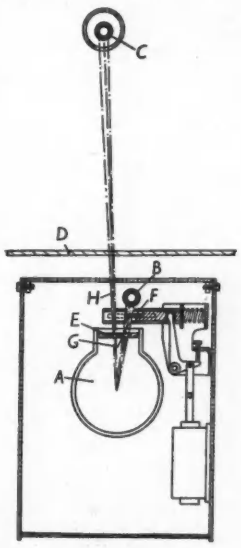
metal tube which is drawn into a smaller diameter at the end *B*. The reduced end is filled by a plug *C* of steel. On its outside, the shaft end has the sleeve-shaped part *D* of a connection piece *E* firmly shrunk on in such a manner that the torque can be transmitted even by means of the shrinkage force or pressure alone. To increase security, one or more pins *F* secure the parts together. The filling piece *C* and/or the connection piece *E* may in some cases also be made of light metal. The connection piece may serve to receive a coupling, such as a universal joint, and is provided, for this purpose, with a formed driving profile.—*October* 28, 1953.

INSTRUMENTS AND MEASURING DEVICES

699,000. August 16, 1951.—MEASUREMENT OF STRIP THICKNESS WITHOUT CONTACT, Exatest Gesellschaft für Messtechnik G.m.b.H., and August Theodor Wuppermann, both of Mulheimer Strasse 14, Leverkusen-Schlebusch 2, Germany.

The invention relates to a process for measuring the thickness of strip material without contact, more particularly for the continuous measurement of



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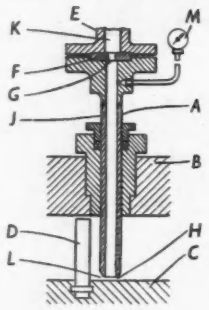
the strip thickness of moving material. The instrument as shown in the drawing employs for a source of rays an X-ray tube *A* and two Geiger-Müller

counting tubes *B* and *C*, arranged on a carriage which may traverse perpendicular to the direction of rolling over the width of the rolled material *D*. The radiation of the X-ray tube *A* is directed through the apertures of a screening plate *E* on to the counting tubes. The gauge plate *F* between the counting tubes *B* and *C* and the plate *D* consists of the same material as that to be measured, and is of the desired thickness, so that in the rest position the counting tubes show the same radiation intensity. For this purpose, the plate *F* is displaced to such an extent that the ray pencils *G* and *H* both pass through the gauge plate, so long as the material to be measured is not in the path of the rays *H*. In the operative position the gauge plate *F* is moved back until the beam to the counting tube *C* passes by it and its intensity is only influenced by the passage through the rolled material *D*, while the intensity of the beam to the counting tube *C* is determined without any change by the thickness of the gauge plate *F*. The reading of the difference in intensity between measurement receivers *B* and *C* indicates the deviation in the thickness of the material measured. In the rest position, adjustment is made to the desired theoretical thickness of the rolled material.—*October* 28, 1953.

STEAM AND GAS TURBINES

698,898. January 29, 1951.—TURBINES, Aktiengesellschaft Brown, Boveri et Cie., Baden, Switzerland.

The object of the invention is to provide an improved arrangement for automatically compensating for changes in radial blade tip clearance in axial flow steam turbines. As illustrated in the drawing, a compensating tube *A* is introduced from the outside into the casing *B* of a turbine, inside a guide blade row or into some other suitable intermediate space, so that the end of the tube facing the rotor *C* is within a distance of about 0·5mm to 1mm from the rotor surface or the shrouding ring of the



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moving blade row *D*. Through the connecting piece *E* a vaporous medium—for instance, live steam—is supplied to the tube at a constant pressure above atmospheric, this medium flowing through a nozzle *F* of suitable cross section *G*. This cross section is expediently selected to be about the same size as the mean cross section *H* of the gap that is formed between the end of the tube and the surface of the rotor during normal service. The pressure *J* between the nozzle and the outlet of the tube is then dependent on the radial clearance between the casing and the rotor, for a given pressure *K* of the supplied medium and a known pressure *L* in the turbine stage under consideration. In that range in which the pressure ratio at the outlet of the tube is above critical, the pressure *J* is independent of the blade stage pressure *L*, so that in this case the accuracy of the compensation is simply attained. The device compensates automatically any variations of blade tip clearance caused by deformation of the casing when the turbine is out of service and various applications are shown in the specification. A manometer *M* denotes every change of pressure in the tube *A*, and thus the radial clearance blade is noted.—*October* 28, 1953.

Launches and Trial Trips

TROUBADOUR, cargo and passenger ship; built by the Netherlands Dock and Shipbuilding Company, for Wilh Wilhelmsen, Norway; length between perpendiculars 440ft, breadth 61ft 6in, depth 40ft 9in, deadweight 8680 tons at 26ft 6¼in draught; trial speed 17·4 knots; N.D.S.M.-Doxford oil engine, six cylinders, 7500 s.h.p. at 115 r.p.m. Launch, October 24th.

CALTEX MANCHESTER, oil tanker; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Overseas Tankship (U.K.), Ltd.; length overall 544ft 4in, breadth moulded 70ft, depth moulded 39ft 9in, deadweight 17,450 tons; twenty-seven cargo oil tanks, one pump room, three horizontal cargo oil pumps, three vertical duplex stripping pumps, steam deck machinery, four-ram electro-hydraulic steering gear; a single set of double-reduction, geared, compound turbine machinery, 8200 s.h.p., takes steam at 450 lb per square inch and 750 deg. Fah. from two Yarrow three-drum boilers, two 400kW generators driven by geared turbines, two 50kW motor-driven generators, one 50kW diesel-driven generator. Trial, October 30th.

RATHLIN HEAD, cargo liner; built by Harland and Wolff, Ltd., for the Ulster Steamship Company, Ltd.; length between perpendiculars 405ft, breadth moulded 58ft 9in, depth moulded to shelter deck 39ft, gross tonnage 7350 tons; two complete steel decks, eight watertight compartments, five cargo holds, steam deck machinery, one 20-ton derrick, two 30kW steam-driven generators, one 30kW diesel-driven generator, one set of double-reduction geared turbines, 3000 s.h.p., take steam at 260 lb per square inch and 625 deg. Fah. from two Babcock and Wilcox marine water-tube boilers. Trial, November 4th.

LONDON PRESTIGE, oil tanker; built by the Furness Shipbuilding Company, Ltd., for the London and Overseas Freighters, Ltd.; length between perpendiculars 560ft, breadth moulded 80ft, depth moulded 42ft 3in, draught 32ft 3½in, deadweight 24,600 tons, trial speed 14 knots; twenty-seven cargo oil tanks, two pump rooms, four 500 tons per hour Duplex steam pumps, two stripping pumps; two 75kW steam-driven generators; N.E.M.-Doxford opposed-piston, two-stroke oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6800 b.h.p. at 119 r.p.m.; one Scotch boiler, one Foster-Wheeler water-tube boiler. Launch, November 5th.

PACIFIC NORTHWEST, cargo and passenger ship; built by Vickers-Armstrongs, Ltd., Walker-on-Tyne, for Furness Withy and Co., Ltd.; length 497ft, breadth 63ft 2in, depth 41ft, deadweight 10,500 tons, load draught 28ft 6in; geared turbine machinery, 7700 s.h.p., service speed 15·5 knots. Launched, November 5th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Tues., Nov. 24th.—W. MIDLANDS SECTION: Technical College, Wulfruna Street, Wolverhampton, "Remote Control Devices and Servo-Mechanisms," A. E. W. Hibbitt, 7.15 p.m.

INCORPORATED PLANT ENGINEERS

Thurs., Nov. 26th.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Oil Injection Method of Separating and Uniting Joints on Shaft Couplings," G. D. Jordan, 7.30 p.m.
Mon., Nov. 30th.—W. AND E. YORKS BRANCH: The University, Leeds, "Some Recent Applications of Electronics in Industry," R. H. Wheat, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Dec. 2nd.—LONDON BRANCH: Waldorf Hotel, W.C.2, "Bell Founding," H. M. Howard, 7.30 p.m.

INSTITUTE OF FUEL

Tues., Nov. 24th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, "The Conservation of the Nation's Fuel and Power Resources," F. M. H. Taylor, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

To-day, Nov. 20th.—MERSEYSIDE AND N.W. SECTION: City Technical College, Liverpool, "Launching of Ships," R. S. Hogg, 7 p.m.
Tues., Nov. 24th.—JUNIOR LECTURE: Royal Technical College, Salford, "Gas Turbines," J. Hodge, 2.15 p.m.——JUNIOR LECTURE: Technical Institute, Falmouth, "Petroleum Refining," E. J. Boorman, 7.30 p.m.

INSTITUTE OF NAVIGATION

To-day, Nov. 20th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Navigation on the U.K. to New Zealand Air Race," 5 p.m.

INSTITUTE OF PETROLEUM

Sun., Nov. 22nd.—STANLOW BRANCH: Tatler Theatre, Chester, Film Show, 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

To-day, Nov. 20th.—YORKSHIRE ASSOCIATION: Hotel Metropole, Leeds, "Atmospheric Pollution: Causes, Effects and Prevention," A. Parker, 7 p.m.
Tues., Nov. 24th.—RAILWAY MEETING: Great George Street, Westminster, London, S.W.1, "Bridge Investigation, Ceylon Government Railways, 1949–1951," Conrad Gribble, 5.30 p.m.
Tues., Dec. 1st.—ROAD MEETING: Great George Street, Westminster, London, S.W.1, "Design and Construction of a High-Speed Test Track for Motor Vehicles," Ralph Freeman and J. A. Neill, 5.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Wed., Nov. 25th.—WEST OF SCOTLAND BRANCH: St. Enoch Hotel, Glasgow, "Non-Destructive Testing of Alloy Steels," John Cameron, 7.30 p.m.
Thurs., Nov. 26th.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester, "The Humorous Aspects of Inspection," D. Avison, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Dec. 1st.—39, Elmbank Crescent, Glasgow, "A Century of Coaster Design and Operation," J. C. Robertson and H. H. Hagan, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Nov. 20th.—N.E. STUDENTS' SECTION: Grey Hall, King's College, Newcastle upon Tyne, "Astronomy," T. W. James, 6.30 p.m.
Mon., Nov. 23rd.—RADIO SECTION: Savoy Place, London, W.C.2, "Loudspeaker Systems: Recent Trends in Design," A. E. Falkus, 5.30 p.m.
Tues., Nov. 24th.—N. MIDLAND CENTRE: British Electricity Authority, 1, Whitehall Road, Leeds, 1, "Meter Problems and Consumers' Load Characteristics," L. B. S. Golds and P. Schiller, 6.30 p.m.——LONDON STUDENTS' SECTION: Savoy Place, W.C.2, "Machines, Animals and Information," B. Z. de Ferranti, 7 p.m.
Wed., Nov. 25th.—SUPPLY SECTION: Savoy Place, London, W.C.2, "A New Approach to the Theory and Operation of Electrostatic Precipitators for Use on Pulverised-Fuel-Fired Boilers," N. Troost, 5.30 p.m.
Mon., Nov. 30th.—RADIO SECTION: Savoy Place, London, W.C.2, Section Soirée, 6.30 p.m.——S. MIDLAND CENTRE: Town Hall, Birmingham, Faraday Lecture, O. W. Humphreys.
Tues., Dec. 1st.—MEASUREMENTS SECTION: Savoy Place, London, W.C.2, Discussion on "The Influence of Legislation on the Costs of Metering," opened by S. Howarth, 5.30 p.m.——S.E. SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "Special Effects for Television Studio Production," A. M. Spooner and T. Worswick, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 20th.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, "Relaxation Methods: A Retrospect," Sir Richard Southwell, 5.30 p.m.——N.E. BRANCH GRADUATES' SECTION: Grey Hall, King's College, Newcastle upon Tyne, "Astronomy," T. W. James, 6.30 p.m.——SCOTTISH BRANCH, GRADUATES' SECTION: Royal Technical College, Glasgow, "Some Aspects of the Repair and Overhaul of Aero-Engines," P. Hanretty, 7.30 p.m.——SOUTHERN BRANCH, GRADUATES' SECTION: Municipal Technical College, Bournemouth, "Servo-Mechanisms," R. A. Middleton, 7.30 p.m.
Mon., Nov. 23rd.—WESTERN BRANCH: Arts Centre, Swindon, "The Mechanics of Tracked Vehicles," J. L. Thomson.
Tues., Nov. 24th.—E. MIDLANDS BRANCH: Gas Show Rooms, Upper Parliament Street, Nottingham, "The Technique of Automatic Winding in Mine Shafts," B. L. Metcalf, 6.30 p.m.
Wed., Nov. 25th.—HYDRAULICS GROUP: Storey's Gate, St. James's Park, London, S.W.1, Discussion, "The Relative Importance of High Pump Efficiency as Compared with Other Factors," 6.45 p.m.——SOUTHERN BRANCH: Technical College, Brighton, "The Production of a Technical Newspaper," B. W. Pendred, 7 p.m.——YORKSHIRE BRANCH: The University, St. George's Square, Sheffield, "Wire Drawing and Wire-Drawing Machinery," S. R. Richards, 6.30 p.m.
Fri., Nov. 27th.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, "Fuel Systems and Controls for Marine Gas Turbines," R. F. Darling; "Main Propulsion Gas Turbine Set for the Oil Tanker 'Auris,'" B. E. G. Forsling, 5.30 p.m.
Fri., Dec. 4th.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, "Comparative High-Temperature Properties of British and American Steels," W. E. Bardgett and C. L. Clark, "A Critical Examination of Procedures Used in Britain and the United States to Determine Creep Stresses for the Design of Power Plant for Long Life at High Temperatures," R. W. Bailey, 5.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Wed., Nov. 25th.—INFORMAL MEETINGS: Conference Room, Fourth Floor, Waterloo Bridge House, London, S.E.1, "Regional Engineering Training: Is it Worth While?" C. E. Palmer-Jones and G. W. P. Hills, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Nov. 23rd.—DERBY SECTION: College of Art, Green Lane, Derby, "Difficulties and Developments in Deep Drawing and Pressing," J. D. Jevons, 7 p.m.
Tues., Nov. 24th.—LUTON SECTION: Town Hall, Luton, "Education and Training of the Production Engineer in Administrative Engineering," Winston Rodgers, 7.15 p.m.
Wed., Nov. 25th.—SHREWSBURY SECTION: Technical College, Shrewsbury, "Organisation and Use of Information in Industry," G. Gilfillan, 7.30 p.m.——WESTERN SECTION: The Grand Hotel, Broad Street, Bristol, 1, "The Protection of Metal Components Against Atmospheric Corrosion," N. R. Laban, 7.15 p.m.
Thurs., Nov. 26th.—COVENTRY SECTION: Church House, Church Street, Rugby, "Electricity's Contribution to Industry," L. Landon Goodman, 7 p.m.——LINCOLN SECTION: Ruston Club, Unity Square, Lincoln, "Foundry Technique in Relation to Engineering Production," G. R. Shotton, 7.30 p.m.——LONDON SECTION: Royal Empire Society, Northumberland Avenue, W.C.2, "Recent Developments in Power Metallurgy," G. R. Bell, 7 p.m.——SOUTHERN SECTION: Polygon Hotel, Southampton, "Industrial Law-Legal Aspects of Factory and Production Managements," H. Peter Jost, 7.15 p.m.——S. WALES SECTION: S. Wales Institute of Engineers, Park Place, Cardiff, "The Fundamentals of Production Management," M. Seaman, 6.45 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Thurs., Nov. 26th.—11, Upper Belgrave Street, London, S.W.1, "The Reconstruction of a Soaking Pit Building," H. C. Husband and K. H. Best, 5.55 p.m.

IRON AND STEEL INSTITUTE

Tues. to Thurs., Nov. 24th to 26th.—4, Grosvenor Gardens, London, S.W.1, Autumn General Meeting.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 20th.—ORDINARY MEETING: Townsend House, Greycoat Place, London, S.W.1, Chairman's Address, "A Consulting Engineer's Casebook," S. R. Broderick, 7 p.m.
Mon., Nov. 23rd.—N.W. SECTION: Engineers' Club, Albert Square, Manchester, "The Treatment of Industrial Effluent," 7 p.m.
Fri., Nov. 27th.—Townsend House, Greycoat Place, London, S.W.1, Annual General Meeting and Annual Meeting of Contributors to the Benevolent Fund, 7 p.m.

LIVERPOOL ENGINEERING SOCIETY

Wed., Nov. 25th.—24, Dale Street, Liverpool, "East Coast Flood Damage," J. V. Spalding, 6 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Nov. 27th.—Engineers' Club, Albert Square, Manchester, "Fluid Couplings and the Application in Electric Motor and Diesel-Engine-Driven Equipment," E. C. Farrer, 6.45 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Nov. 27th.—Mining Institute, Newcastle upon Tyne, "Experience During the Last Ten Years in the Design of Marine Boilers," R. L. J. Hayden, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Nov. 24th.—College of Technology, Sackville Street, Manchester, 1, "Recent Developments in Prestressed Concrete Construction," A. J. Harris, 6.45 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., Nov. 26th.—GRADUATES' AND STUDENTS' SECTION: 4, Hamilton Place, London, W.1, "The Case for the Light Fighter," P. A. Norman, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY, LTD.

Tues., Nov. 24th.—Manson House, Portland Place, London, W.1, "Unusual Aspects of Automatic Control in the Chemical Industry," R. D. Mylon, 7 p.m.